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Genotype and Environmental Factors Affecting Birth and Postnatal Weights of Prolific Javanese Sheep

Subandriyo[1] **and I. Inounu**[1]

Small Ruminant-CRSP/Central Research Institute for Animal Sciences,
P.O. Box 308, Bogor 16003, Indonesia

ABSTRACT: A study to evaluate the effect of genotype of dam ($FecJ^+FecJ^+$; $FecJ^+FecJ^-$; $FecJ^FFecJ^+$; $FecJ^FFecJ^-$; and $FecJ^FFecJ^F$) and environmental factors on birth weight (BW) and postnatal weights at 30 days (W30), at 60 days (W60), at 90 days (W90) and at 120 days (W120) were conducted on Javanese prolific sheep flock from 1991 to 1993. Factors affecting birth weight and all postnatal weights were year, sex of lamb and birth type (P<0.01). Dam age was significant for BW (P<0.05) and W30 (P<0.01), respectively, and nearly significant for W120 (P<0.1), but not significant for W60 and W90. The dam genotype effect was significant for BW (P<0.001) and W60 (P<0.05), respectively, but not significant for other weights. Lambs born from dam carrying prolific gene ($FecJ^F$) tended to have lower birth weight and postnatal weights.

Key Words: Sheep, Javanese, Prolific, Genotype, Environmental, Postnatal

Introduction

Approximately 50% of the sheep population in Indonesia is found in West Java and predominantly comprises an indigenous breed known as the Javanese Thin Tail (JTT) (DGLS, 1991). Sheep in West Java, likewise other livestock, are kept in small flocks integrated into intensive agricultural production systems. In these traditional production systems the animals are usually stall-fed or kept under a combination of stall feeding and grazing. During the past 12 years research at the Agency for Agricultural Research and Development (AARD), the Research Institute for Animal Production (RIAP) in collaboration with the Small Ruminant-Collaborative Research Support Program (SR-CRSP), has determined the genetic potential of JTT sheep. Ewes of this breed, as tropical sheep in general, can reproduce year-round. It has been shown that the ability to reproduce year-around alone, under an intensive breeding program, can increase the production of lambs up to 150%. A single gene ($FecJ^F$) present in these populations is responsible for much of this variation. Animals can be classified into three genetic groups which are animals that carry two prolificacy genes ($FecJ^FFecJ^F$), one gene ($FecJ^FFecJ^+$), and none ($FecJ^+FecJ^+$). Ewes that carry $FecJ^F$ gene usually have high prolificacy. Animals born to ewes that carry $FecJ^F$ are usually smaller than animals born to ewes that do not carry the the gene (Bradford et al., 1991; Inounu, 1991). The objective of this study was to evaluate the effect of genotype of dam and environmental factors on the five weight traits of Javanese prolific sheep.

Materials and Methods

The data for this study were from the records of the SR-CRSP/Research Institute for Animal Production sheep flock from 1991-1993. Sheep flock is located in CRIAS' Bogor compound. It has access to 1.8 ha pasture of King grass, which are intensively managed to produce about 600-900 kg of fresh forage per day. All animals are kept under total confinement and lambs are weaned at 90 days. Animals supplemented with concentrate containing 16% protein, 4% fat, 7% crude fiber, 8% ash, 12% digestible protein and 68% total digestible nutrient. The concentrate ration was given approximately in the rate of 2.0% of body weight. Animals received fresh chopped King grass approximately in the rate of 13% of body weight.

The weights included in this study were birth weight (BW) and postnatal weights recorded for 30-d (W30); 60-d (W60), 90-d (W90) and 120-d (W120) of age. Ages of postnatal weights were 16-44 days for W30; 46 - 74 days for W60, weaning

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Table 1. Number of observations (N), Least squares means (LSM), standard errors (SE) for birth weight (BW), adjusted 30-d weight (W30), adjusted 60-d weight (W60), 90-d weaning weight (W90) and adjusted 120-d weight (W120)

	BW (kg)		W30 (kg)		W60 (kg)		W90 (kg)		W120 (kg)	
Variable	N	LSM (SE)	N	LSM (SE)	N	LSM (SE)	N	LSM (SE)	N	LSM (SE)
Year		***		**		**		***		***
1991	181	1.9(0.07)	136	6.1(0.20)	156	9.4(0.45)	157	12.3(0.38)	51	14.7(0.54)
1992	148	2.1(0.06)	33	5.4(0.25)	117	8.0(0.43)	123	10.6(0.36)	98	10.8(0.44)
1993	160	2.2(0.06)	129	6.1(0.16)	116	9.1(0.39)	114	11.0(0.33)	102	13.6(0.37)
Sex		**		**		***		***		***
Ewe	258	2.0(0.05)	153	5.7(0.17)	199	8.3(0.37)	204	10.7(0.31)	131	12.2(0.39)
Ram	231	2.2(0.05)	145	6.0(0.17)	190	9.4(0.36)	190	12.0(0.31)	120	13.9(0.38)
Birth type		***		***		***		***		***
Single	104	2.7(0.07)	70	8.1(0.20)	92	11.0(0.44)	96	15.0(0.37)	61	16.8(0.46)
Twin	208	2.2(0.05)	119	6.0(0.17)	172	9.2(0.36)	179	11.3(0.31)	117	12.9(0.36)
riplet	130	1.7(0.06)	85	4.7(0.19)	95	7.5(0.43)	90	9.2(0.37)	54	11.3(0.47)
Quad	47	1.8(0.10)	24	4.6(0.32)	30	7.8(0.71)	29	9.7(0.61)	19	11.2(0.74)
Dam Age (yr)		*		**		NS		NS		+
2	181	1.9(0.05)	116	5.2(0.17)	145	8.2(0.36)	149	10.6(0.30)	72	12.0(0.36)
3	123	2.1(0.06)	49	5.8(0.19)	102	9.1(0.40)	107	11.5(0.33)	88	12.9(0.39)
4	130	2.1(0.06)	105	5.6(0.17)	99	8.8(0.41)	95	11.5(0.35)	60	13.5(0.50)
5	32	2.2(0.10)	11	6.4(0.37)	26	9.3(0.68)	26	11.6(0.58)	20	13.5(0.65)
6	23	2.1(0.12)	17	6.1(0.33)	17	8.9(0.83)	17	11.4(0.71)	11	13.3(0.90)
Dam Genotype		***		NS		*		NS		NS
$FecJ^{+}FecJ^{+}$	78	2.4(0.08)	56	6.0(0.23)	71	10.1(0.48)	73	11.6(0.41)	47	13.4(0.48)
$FecJ^{+}FecJ^{-}$	28	2.2(0.11)	16	6.1(0.34)	22	9.3(0.73)	26	11.5(0.60)	22	13.1(0.68)
$FecJ^{F}FecJ^{F}$	150	2.0(0.04)	89	5.7(0.14)	116	8.2(0.29)	116	11.4(0.25)	68	12.8(0.33)
$FecJ^{F}FecJ^{+}$	213	2.1(0.06)	126	5.9(0.18)	168	8.6(0.38)	166	11.7(0.32)	105	13.4(0.40)
$FecJ^{F}FecJ^{-}$	20	1.8(0.12)	11	5.5(0.37)	12	8.0(0.91)	13	10.4(0.76)	9	12.5(0.93)

*** P<0.001; ** P<0.01; * P<0.05; + P<0.1; NS - Non Significant weight at 90 days for W90, and 97-134 days for W120.

The dam genotypes considered in this study were $FecJ^FFecJ^F$, $FecJ^FFecJ^+$, $FecJ^+FecJ^+$, for the ewes in which both alleles had been identified, and $FecJ^FFecJ^-$ and $FecJ^+FecJ^-$ for individuals in which only one allele was known. The environmental factors consider in this study were year of birth, birth type, age of dam and sex of lamb.

To account for variation due to lamb age in the three postnatal weights, postnatal growth rates were calculated as linear regressions of W30, W60 and W120 on lamb age at weighing. The following linear statistical model was employed to obtain these regression coefficients (SAS, 1988).

$$WT_{ijklm} = \mu + Y_i + S_j + T_k + A_l + DG_m + b(Age_{ijklm}) + \in_{ijklmn}$$

where: WT_{ijklmn} = observation of the n^{th} W30, W60, or W120 in the i^{th} year, j^{th} sex of lamb, k^{th} birth type of lamb, l^{th} dam age at lambing, m^{th} dam genotype; μ = overall population mean for any of the three postnatal weights; Y_i = the effect of i^{th} year of lamb born; S_j = the effect of j^{th} sex of lamb; T_k = the effect of k^{th} birth type of lamb; A_l = the effect of l^{th} dam age at lambing; DG_m = the effect of m^{th} dam genotype; b = linear regression coefficient; Age_{ijklmn} = the effect of covariable age of lamb; $\in_{ijklmn}$ = random residual error term.

The three postnatal weights, then, were adjusted to an age constant basis using the following formula.

Age-adjusted weight = Weight + b (Constant age - Age), where: Age-adjusted weight is the age-adjusted value for W30, W60, or W120; Weight is the actual W30, W60 or W120; b is the linear regression for W30, W60, or W120 obtained from previous analyses; Constant age is 30, 60, or 120 days; Age is the actual age (days) of the lamb at weighing.

To account the effect of dam genotypes and environmental factors, the following linear statistical model (SAS, 1988) was employed.

$$WT_{ijklm} = \mu + Y_i + S_j + T_k + A_l + DG_m + \in_{ijklmn}$$

where: WT_{ijklmn} = observation of the n^{th} BW, age-adjusted W30, age adjusted W60, weaning weight at 90-d of age (W90) or age-adjusted W120 in the i^{th} year, j^{th} sex of lamb, k^{th} birth type of lamb, l^{th} dam age at lambing, m^{th} dam genotype; μ = overall population mean for any of the three postnatal weights; Y_i = the effect of i^{th} year of lamb born; S_j = the effect of j^{th} sex of lamb; T_k = the effect of k^{th} birth type of lamb; A_l = the effect of l^{th} dam age at lambing; DG_m = the effect of m^{th} dam genotype; $\in_{ijklmn}$ = random residual error term.

Results and Discussion

Adjustment of W30, W60 and W120 to an Age Constant Value

Analyses of variance and mean squares showed that year of birth had significant (P<0.05, 0.01, P<0.001) effects on unadjusted W30, W60 and W120, respectively. Sex effect was significant (P<0.01, P<0.001, P<0.001) for unadjusted W30, W60 and W120, respectively. Lamb birth type influenced significantly (P<0.001) all three postnatal weights. Dam age effect was significant (P<0.01) for unadjusted W30 and nearly significant (P<0.1) for unadjusted W120, but was not significant for unadjusted W60. Dam genotype effect was significant (P<0.05) only for unadjusted W60. Linear regression effects of lamb age were significant (P<0.001) for all three postnatal weights.

Postnatal growth rates of the three postnatal weights were 0.0954 ± 0.0129, 0.0737 ± 0.0254 and 0.0869 ± 0.0312 kg/d for W30, W60 and W120, respectively. Growth rates tend to decrease as the animals get older.

Factors Affecting BW and Postnatal Weights

Analyses of variance and mean squares showed that year, sex of lamb and birth type influenced significantly (P<0.01) BW and all postnatal weights. Dam age was significant for BW (P<0.05), W30 (P<0.05), respectively, and nearly significant for W120 (P<0.1), but not significant for W60 and W90. The dam genotype effect was significant for BW (P<0.001) and W60 (P<0.05), respectively, but not for other weights.

Least squares means (LSM) and standard errors (SE) by year of lamb born, sex of lambs, birth type of lambs, dam age at lambing, dam and sire genotype are given in (Table 1). LSM of BW shows that BW increased from 1991 to 1993, but other weights decreased in 1992 and increased again in 1993. These results suggest that fluctiation of feed supply influenced the weight of lambs.

LSM by sex of lambs for all weights show that ram lambs are heavier than ewe lambs as expected. Ram lambs are 10, 5, 13, 12, and 14% heavier than ewe lambs, respectively, for BW, W30, W60, W90 and W120.

Lambs born in larger litters are smaller than single-born lambs. Single-born lambs were 22, 59 and 50% heavier than twin-, triplet-, and quadruplet-born lambs, respectively, for BW. For W30 single-born lambs were 35, 73, 76% heavier than twin-, triplet- and quadruplet-born lambs. For W60 singles were 20, 47, 41% heavier than twins, triplets and quadruplets. For weaning at 90-d of age (W90), single- born lambs were 33, 63, 55% heavier than twin-, triplet-, quadruplet-born lambs. While at 120-d, singles were 30, 49, 50% heavier than twins, triplets and quadruplets. These results suggest that the differences due to birth type reduce as the animals get older. This is probably due to reducing competition among lambs the limited milk supply and diminishing maternal effects with increasing lamb age.

A curvilinear effect of dam age on lamb weight was found in this study. Weights of lambs tended to increase with dam age up to 5 years, then decline.

LSM by dam genotype (Table 1) indicate that the weight of lambs born from the ewes that carry $FecJ^F$ allele tend to be smaller than ewes that do not carry prolificacy gene. This is due to the ewes that carry this allele have higher prolificacy. Bradford et al. (1991) indicate that ewe with one copy of this allele will increase the prolificacy by 0.75.

Conclusions

Results of the study showed that dam genotype affected significantly on birth weight (BW) and weight at 60 days (W60). Lambs born from the ewes that carry $FecJ^F$ allele tend to have lighter birth weights than ewes that do not carry prolificacy gene. Environmental factors that influenced significantly on birth and postnatal weights were year of birth, sex and birth type. Age of dam affected significantly only on birth weight (BW) and weight at 30 days (W30)

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