The Effect of Castration on Growth and Body Composition of Javan Rusa Stags

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ABSTRACT : The effects of castration on growth and body composition of Javan rusa (*Cervus timorensis russa*) stags were examined at three slaughter ages in three experiments. Castration had no effects on growth rates, or liveweights at periodic weighings, at any stage in Experiments 1 and 2, when the stags were slaughtered at 19 and 13 months of age, respectively. In Experiment 3, monthly liveweights of castrated and entire stags were not significantly different until the stags were 21 months old. From this age, when they had recovered from their first rut season and were in their second spring/early summer, the entires grew more rapidly than the castrates. There were seasonal changes in growth in both treatments, indicating that pasture conditions influenced performance. Liveweights of entires and castrates were similar in stags slaughtered at 13 and 19 months, but castrates were smaller than entires at 25 months. Castration reduced the size of the head and skin, but there was little important effect of castration on body components at any slaughter age. Castration can be recommended as a management tool for rusa stags, especially if the animals are to be slaughtered before they exceed 19 months of age. *(Asian-Aust. J. Anim. Sci. 2001. Vol. 14, No. 5 : 608-614)*

Key Words : Rusa Stags, Castration, Growth, Body Composition

INTRODUCTION

Rusa deer (*Cervus timorensis*) are native to the Indonesian archipelago. Following their introduction to several countries in the Indian Ocean and Asia/Pacific regions, the Javan rusa (*C. t. russa*), in particular, have become a widely-farmed tropical species. Because venison is the most important commercial product of the rusa deer species, and thus of the tropical deer industry, it is essential that strategies for efficient meat production are developed.

In Australia, Javan rusa stags are slaughtered typically between 12 and 24 months of age (Woodford and Dunning, 1992). Data on seasonal variations in growth are important because deer must reach a carcase weight at slaughter of at least 40 kg (Sinclair, 1997), and it is advisable to slaughter during or immediately after periods of maximum growth.

Rusa stags initiate their first rut at approximately 14 to 16 months of age, when they undergo a phase of reduced growth and become more difficult to handle. This state of sexual activity may last for up to three months. Van Mourik and Stelmasiak (1985) have shown that testosterone secretion in rusa stags peaks during the rut. This is associated with increases in neck girth, hardening of velvet antler, initiation of wallowing activity and increased aggression towards other males in entire rusa stags. Of concern to meat production and quality, elevated testosterone in stags is associated with a reduction in feed intake and loss of weight (Suttie and Kay 1985; Woodford and Dunning 1992).

Stevenson et al. (1992) have reported meat of poorer quality from red deer stags slaughtered during the rut and post-rut period. Hogg et al. (1990) and Mulley and English (1985) have shown that castration of fallow deer eliminated rutting behaviour, improved ease of handling, increased carcase fatness, and maintained body condition. Thus castration may be a useful way of managing stags destined for venison production.

Venison production strategies should take into account seasonal changes in the growth of stags. Castration may possibly affect seasonal growth. The work reported here addresses these issues, in particular the effect of castration on the growth and body composition of rusa stags slaughtered at three commercially relevant ages.

MATERIALS AND METHODS

Experimental design, animals and management

Rusa stag fawns were surgically castrated or left entire, and the effects of these treatments on growth and body composition were compared in three completely randomised experiments. Experiment 1 (slaughter at 19 months) was conducted from March 1991 to October 1992 with 15 male rusa fawns (approximate birth weight 5.2 kg). The fawns were weaned in mid-August 1991 at (mean±SD) 31±3.8

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Received September 15, 2000; Accepted December 11, 2000

kg liveweight, when they were on average 23 weeks of age. At 31 weeks of age, 7 fawns weighing 42±3.9 kg, were surgically castrated and the others, weighing 43±4.9 kg, were left entire. The animals used in Experiments 2 and 3 were 24 males from the February/April 1992 fawning. These were weaned at 5 months (mid-August, 1992). Twelve fawns were retained as entires, and 12 were castrated 3 weeks after weaning, at an average of 26 weeks of age, when their pedicles were starting to grow actively. There were 4 accidental deaths, not related to castration, following the selection of animals into these experiments. Consequently Experiment 2 (slaughter at 13 months) involved 5 castrates weighing 37.0±0.86 kg and 4 entires weighing 39.0±1.2 kg at selection, and Experiment 3 (slaughter at 25 months) involved 4 castrates weighing 34.0±3 kg and 7 entires weighing 38±1.5 kg at selection.

In all experiments the castrates and entires were run together with a herd of mature males until slaughter. Pastures were kikuyu (*Pennisetum clandestinum*) and white clover (*Trifolium repens*) from autumn to spring, and were predominantly couch grass (*Cynodon dactylon*) and green panic (*Panicum maximum*) from late spring to late summer. Supplements of lucerne and/or grass hay and sorghum grain were given during periods of pasture shortage.

Measurements

Growth rates were calculated from non-fasted liveweights (measured between 0800 and 1000 h) recorded every 4 weeks. Seasonal growth was investigated by calculating the average daily gains in autumn (March to May), winter (June to August), spring (September to November) and summer (December to February).

The animals were slaughtered at the following ages and times: in Experiment 1, October 1992 at 19 months (spring, entires post-rut and in hard antler); in Experiment 2, May 1993 at 13 months (autumn, entires in velvet spike antler before their first rut); and in Experiment 3, April 1994 at 25 months (autumn, entires in velvet antler, pre-rut). To facilitate carcase dissection, the deer were slaughtered in lots of 4 (2 castrates and 2 entires) at weekly intervals. Animals were weighed, transported 10 km to the abattoir in a completely enclosed cattle truck with 2 companion deer, and despatched with a shot to the head.

The carcases were bled by severing the carotid and jugular veins, then electrically stimulated for 90 seconds using a rectal-nasal probe and a peak voltage of 45 volts. They were dressed by an "inverted dressing" procedure in which the head was removed at the atlanto-occipital joint, and the fore and hind feet removed at the carpo-metacarpal and tarso-metatarsal joints, respectively. The hide on the shoulder and neck was cleared, then pulled caudally until it was completely removed from the hind legs. The carcase was eviscerated with the kidney and peri-renal fat left in the carcase.

Neck and heart girths were measured immediately after slaughter. The hot carcase weight (HCW, i.e. after removal of the head, hide, feet, blood, thoracic organs and alimentary tract), and the weights of the hide, head and feet were recorded within 2 h of slaughter. Other measurements were made on carcases and organs which had been chilled for 24 h at 4℃. The thoracic organs were weighed together, then the heart, lungs, liver, spleen and fat were weighed separately. The alimentary tract was weighed full, then the reticulo-rumen was separated and weighed both full and empty. The visceral fat was separated from the rumen and intestines and weighed. Cold carcase weights were recorded at 24 h post-mortem to estimate carcase shrinkage.

Statistical analysis

Although all the deer came from the same herd and 2 of the 3 experiments were started at the same time and ran concurrently for their first year, it was considered that between-experiment comparisons would be biased by the differences which were observed in pasture availability throughout the 3.5 years of the study, and which would have had different effects on the three slaughter-age comparisons. Support for this conservative approach is that the overall growth rate error variances varied from 2.31 in the 13 months group to 7.92 in the 25 months group. Consequently, the data from the different experiments were evaluated separately.

Data from each experiment were subjected to analysis of variance using a general linear model (Statistical Analysis Systems 1988). Statistical significance was assessed at the 5% level, except when otherwise stated. Whenever there was a significant F-test, LSD were generated and least square means were used to test the differences between treatments. Liveweight at selection into the experiments was used as a covariate in the analysis of body composition. Stepwise regression analysis was used to derive liveweight prediction equations. Growth rate was analysed using a split plot repeated over time, the model was (where treatment is castration or not):

Weight=treatment deer(treatment) month treatment× month/ss3;

Test H=treatment E=deer (treatment)

RESULTS

Growth

Liveweights from 2 months to slaughter for all experiments are shown in figure 1 and detailed weights for the stags slaughtered at 25 months (Experiment 3) are reported in table 1. After checks caused by weaning and castration, especially in Experiments 2 and 3, growth was rapid and relatively constant until the stags were 9 to 10 months of age. There were no differences between treatments at any month in Experiments 1 or 2. At slaughter, entires in Experiment 1 were only 3.1 kg (or 3.7%) heavier than their castrated counterparts, and in Experiment 2 the entires weighed 0.6 kg (0.6%) less than the castrates. In Experiment 3, liveweights of castrates and entires were similar until December of the second year; but they then grew at different rates until the entires weighed 15.4 kg ($p<0.05$) more at slaughter.

Linear growth rates from 2 months to slaughter (kg/month; mean±SD) of stags slaughtered at 13 months were 4.04±0.295 (castrates) and 3.87±0.190 (entires), for those slaughtered at 19 months were 3.52 ±0.165 (castrates) and 3.58±2.96 (entires), and for stags slaughtered at 25 months were 2.68±0.288 (castrates) and 3.03±0.273 (entires). Growth was also described by regression of liveweight (Lwt, kg) on age (M, months), with liveweight at castration (CLwt, kg) as a covariate. These equations are in table 2.

Growth rates of all stags were highest in their first autumn, winter and spring and (within experiments) were not different, either between treatments or these seasons (table 3 and figure 2). In Experiments 2 and 3 growth declined from first spring to first summer. In all experiments the deer, irrespective of treatment, grew most slowly in their second autumn. Stags in Experiment 3 experienced a significant ($p<0.05$) increase in growth in their second spring which lasted until their third autumn, when they were slaughtered. In this experiment, 2 entires lost 1 to 2 kg in the rut (July and August), but the entires grew more quickly than the castrates after their second winter (table 1). The overall average daily gain of the entires slaughtered at 25 months was 21 g/day higher than that of the castrates, but that difference tended to significance only ($p=0.10$).

Table 1. Least square mean monthly liveweights of castrated and entire Javan rusa stags, from 2 to 25 months of age (Experiment 3)

Month	Season	Age (month)	Treatments	
			Castrates (n=4)	Entires (n=7)
May 1992	Autumn	2	17.7	16.7
June		3	19.5	20.9
July		4	24.5	25.1
August	Winter	5	29.8	31.6
September		6	34.0	35.8
October	Spring	7	33.8	36.1
November		8	41.8	45.3
December	Summer	9	46.8	50.0
January 1993		10	52.0	55.2
February		11	55.0	60.6
March		12	58.0	63.7
April		13	58.8	63.9
May	Autumn	14	59.0	64.1
June		15	58.3	62.5
July		16	60.8	65.7
August	Winter	17	60.5	65.6
September		18	62.8	69.4
October	Spring	19	67.8	74.7
November		20	71.5	79.1
December	Summer	21	72.3	84.0
January 1994		22	75.3	84.6
February		23	80.5	91.3
March		24	80.3	93.8
April	Autumn	25	83.5	95.9
Slaughter		25.5	85.5	100.9

[1] LSD for comparing treatments within the same month= 8.15; LSD for comparing the same treatment in different months = 3.90 for castrates and 2.95 for entires.

Neck and chest circumferences

Neck circumferences (mean±SE) of castrates and entires respectively, were at 13 months 36±0.8 and 37±0.9 cm, at 19 months 36±2.6 and 47±2.5 cm, and at 25 months were 38±1.4 and 44±0.9 cm. Chest circumferences of castrates and entires were 91 ±1.6 and 89±1.8 cm at 13 months, 97±1.4 and 98 ±1.3 cm at 19 months, and at 25 months were 95± 1.1 and 100±0.8 cm. Neck girths differed between treatments ($p<0.05$) at 19 and 25 months. There were no differences in chest girths at 13 or 19 months. At 25 months chest girths of entires were larger ($p<0.05$) than those of castrates.

Body components

Slaughter liveweights, hot carcase weights (HCW) and organ weights of rusa deer are shown in table 4. When stags were slaughtered at 13 and 19 months of age (Experiments 1 and 2) castration had no effect on liveweights at slaughter or HCW. The heads (without antlers) of entire stags slaughtered at 13 and 19 months weighed 20 and 13% more, respectively, than those of castrates ($p<0.01$). In Experiment 2 (slaughter at 13 months) the skin of entires was 19% heavier than that of castrates ($p<0.01$). In Experiment 3, the HCW of 25-month old entires were nearly 6 kg heavier ($p<0.05$) than the castrates.

Dressing percentages (HCW as a proportion of the slaughter liveweight) varied from 56 to 66%, and was highest at 19 months. Castration increased dressing percentages in stags slaughtered at 19 and 25 months. At 25 months of age much of this difference was in the weight of the rumen contents ($p<0.01$).

Table 2. Polynomial equations for predicting the liveweight (Lwt, kg) of castrated and entire rusa stags from age at slaughter (M, months) and liveweight at castration (CLwt, kg)[1]

Age at slaughter	Equation	R^2
13 months:		
Castrates	Lwt (kg)=2.53 (±0.84)M+0.47 (±0.13)M^2-0.028 (±0.01)M^3+1.10 (±0.16)CLwt-25.56 (±6.26)	0.98
Entires	Lwt (kg)=3.06 (±0.74)M+0.34 (± 0.11)M^2-0.022 (±0.004)M^3+0.90 (±0.12)CLwt-17.86 (±4.75)	0.99
19 months:		
Castrates	Lwt (kg)=5.28 (±0.711)M+0.27 (±0.19)M^2-0.042 (±0.0104)M^3+ 0.00026 (±0.0003)M^4+0.91 (±0.034)CLwt-30.11±1.79	0.91
Entires	Lwt (kg)=2.33 (±1.49)M+0.88 (±0.29)M^2-0.085 (±0.022)M^3+0.0023 (±0.001)M4+0.50 (±0.09)CLwt-7.84 (±4.49)	0.91
25 months:		
Castrates	Lwt (kg)=7.16 (±0.53)M-0.35 (±0.05)M^2+0.007 (±0.001)M^3+0.63 (±0.07)CLwt-14.26 (±2.89)	0.97
Entires	Lwt (kg)=8.04 (±0.49)M-0.41 (±0.042)M^2+0.009(±0.001)M^3+1.25 (±0.09)CLwt-38.94 (±3.57)	0.97

[1] coefficients±SE

DISCUSSION

The entire stags in these experiments grew at rates comparable to those reported for Javan rusa in Australia by Woodford and Dunning (1992). These authors reported liveweights of between 80 and 107 kg at 13 to 26 months, which are similar to those reached by the entire stags in this study. High (150 to 200 g/d) and approximately linear growth was observed in the weaners during the first 9 months of each experiment, with reductions in the second winter and spring. These results are similar to those recorded in New Zealand by Semiadi et al. (1993) for sambar deer (*Cervus unicolor*), and appear to be a reasonable model of the growth of young tropical deer.

There were seasonal variations in growth after one year of age, although these tropical stags did not lose weight in winter to the extent observed in temperate species (eg. red deer: Suttie et al., 1983). Growth was lowest in the second autumn in both castrates and entires, indicating that change in seasonal conditions, as well as the stags' reproductive cycle, influences growth in rusa deer. There was a difference between experiments in the average daily gain recorded in the first winter. Deer in Experiment 1 had higher average daily gains than in Experiments 2 and 3, possibly because 1991 was a wetter year than 1992 or 1993, and would have given more grass growth in these

Table 3. Mean seasonal growth rates of Javan rusa stags slaughtered at 13, 19 or 25 months of age (pooled data for castrates and entires)

Season	Seasonal mean growth (g/d)		
	Slaughter at 13 months	Slaughter at 19 months	Slaughter at 25 months
Autumn	212[a]	184[a]	187[a]
Winter	181[a,b]	194[a]	164[ab]
Spring	195[a]	179[ab]	189[a]
Summer	96[c]	147[bc]	99[c]
Autumn	23[d]	50[d]	14[d]
Winter		77[d]	76[c]
Spring		147[bc]	110[bc]
Summer			121[b]
Autumn			122[b]
2 month of age to slaughter	147	133	124

[a,b,c,d,c.] Means within the same column with same superscript are not different (p>0.05).

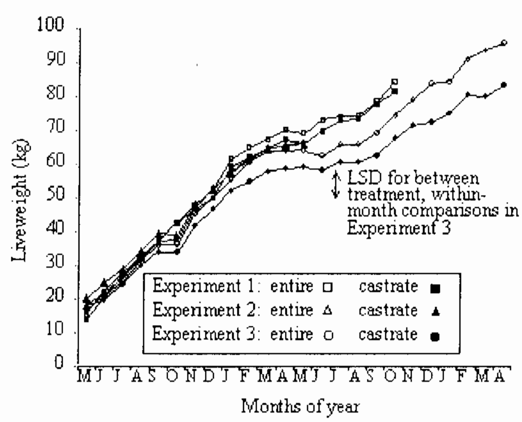

Figure 1. Unfasted liveweights (least squares means) of castrated and entire rusa stags from 2 months of age to slaughter at 13, 19 or 25 months

dryland pastures.

Although data from other species of deer (fallow deer: Mulley and English, 1985; Asher, 1986, 1988; Asher et al., 1987; Hogg et al., 1990; red deer: Blaxter et al., 1974, Kay et al., 1981) suggest that castrates may grow slightly more slowly than entire stags, this study demonstrates that castration of Javan rusa stags does not significantly reduce liveweight at 13 or 19 months. There was no difference in slaughter liveweight at 13 months, and at 19 months the castrates were only 3.1 kg (3.7%; $p>0.05$) lighter than the entires. In this respect, the results agree with those of Kay et al. (1981) who observed non-significant differences at 15 months between castrated and entire red deer kept on poor quality pasture. Similarly, with fallow deer Mulley (1990) reported a difference of 3.5 kg at 17 months, and Hogg et al. (1990) observed differences of 3.5 kg at 12 months and 6.5 kg at 24 months. The effects of castration on growth may be related to age. In the second spring and early summer of Experiment 3, when entires may have experienced compensatory growth after the previous rut, average daily gain was significantly higher for entires than castrates ($p<0.05$). In the second summer and third autumn (early May), entires grew faster than castrates as they possibly accumulated reserves for the forthcoming rut. In New Caledonia, Le Bel et al. (1995) also reported that castration reduced growth of Javan rusa stags by 6.8 % at 24 months and 8.7 % at 30 months.

Rusa males slaughtered at 19 and 25 months, but not at 13 months, produced marketable carcases (eg. at least 40 kg; Sinclair, 1997). The dressing percentages of these rusa males were high, and comparable to values previously reported for the same species (60 to 62%) by Woodford and Dunning (1992), and for the tropical chital (*Axis axis*) deer by English (1992). The values were much higher than those of reindeer (*Rangifer tarandus*) which are approximately 46% (Nieminen 1994), and higher than values reported for castrated Australian fallow deer (Mulley and English 1985, 1992) or red deer in the United Kingdom (Kay et al. 1981). However, Drew et al. (1978) have reported similar dressing percentages for castrated and entire red deer in New Zealand.

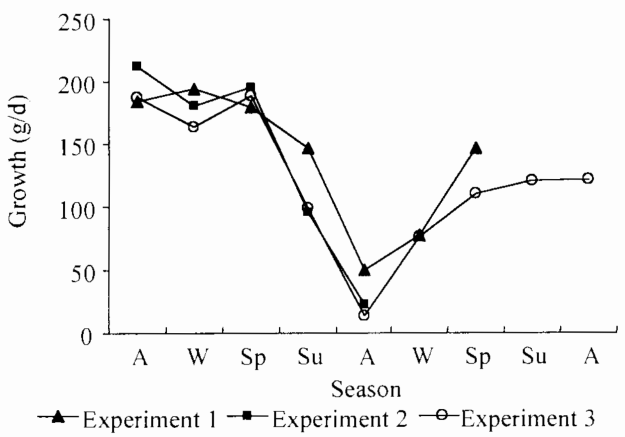

Figure 2. Seasonal average daily gain of rusa stags, slaughtered at 13 (Experiment 2), 19 (Experiment 1) or 25 (Experiment 3) months of age (A=autumn, W=winter, Sp=spring, Su=summer)

Table 4. Least squares mean weights of body components of castrated and entire Javan rusa stags, slaughtered at 13, 19 or 25 months of age and corrected for liveweight at selection

	Component weight (kg)		Proportion of slaughter liveweight (%)	
	Castrates	entires	Castrates	entires
Experiment 1 (slaughter at 19 months)				
Slaughter weight	81.7	84.8	100	100
Carcase	53.8	53.9	65.8[a]	63.6[b]
Head	3.3[A]	3.9[B]	4.0[A]	4.5[B]
Skin	5.6[A]	6.9[B]	6.8[A]	8.1[B]
Thoracic organs	2.3	2.3	2.9	2.8
Hooves	1.9	2.0	2.4	2.3
Blood	3.1	3.3	3.8	3.9
Digestive tract[1]	10.3	11.0	12.6	13.0
Shrinkage[2]	1.6	2.4	2.0	2.8
Experiment 2 (slaughter at 13 months)				
Slaughter weight	66.6	67.5	100	100
Carcase	37.3	37.7	56.0	55.9
Head	2.7[A]	3.2[B]	4.0[a]	4.8[b]
Skin	4.3	4.4	6.4	6.4
Thoracic organs	1.9	1.9	2.9	2.8
Hooves	1.7	1.8	2.6	2.6
Blood	2.4	2.5	3.6	3.7
Digestive tract	15.1	14.8	22.7	21.9
Shrinkage	1.2	1.2	1.9	1.8
Experiment 3 (slaughter at 25 months)				
Slaughter weight	85.5[a]	100.7[b]	100	100
Carcase	51.1[a]	56.9[b]	59.8[A]	56.5[B]
Head	3.4	4.0	4.0	4.0
Skin	5.2[A]	6.7[B]	6.1[a]	6.7b
Thoracic organs	2.5	2.8	2.9	2.7
Hooves	1.9	2.1	2.2	2.1
Blood	3.0	3.4	3.5	3.3
Digestive tract	14.4[A]	18.9[B]	16.9[A]	18.7[B]
Shrinkage	4.1	6.2	4.8	6.1

[a,b] [A,B] Within rows and either component weights or proportions of slaughter weight, means with different superscripts are different ([a,b]: $p<0.05$; [A,B]: $p<0.01$).
[1] Including digestive tract contents.
[2] Loss of weight between weighing before transport and after slaughter 3 to 4 h later, and includes trim losses.

Dressing percentages were highest in the 19 months old deer. These were slaughtered in the post-rut period, in October, when their digestive tract was approximately 60% that of stags slaughtered in the pre-rut period in April/May. Castration increased the dressing percentage by reducing the absolute weight and percentage of the head at 13 and 19 months, the skin at 19 and 25 months, and of the digestive tract at 25 months. This is consistent with the results of Le Bel et al. (1995) who reported a significant 1% increase in dressing percentage following castration. The lack of any adverse effect of castration on dressing percentage in rusa deer contrasts with Mulley and English (1985, 1992) and Kay et al. (1981) who observed lower dressing percentages in castrated fallow and red deer, respectively.

This study has demonstrated that castration may reduce liveweight significantly when deer are slaughtered at 25 months, but not at 13 or 19 months. Stags slaughtered at 13 and 19 months grew at similar rates, but the effects of the rut (from June to August in this species in northern Australia) may give a carcase at 19 months which has a lower proportion of valuable joints (Sookhareea et al., 2000). In terms of feed efficiency and cost of production (which are influenced by growth rate), and carcase value (which is influenced by season in relation to the rut), slaughter at 13 months may be the most profitable, provided that these animals have reached an acceptable carcase weight. As this was not achieved from the pasture-based feeding system used in the present experiments, higher-quality forage or more concentrates may be required to achieve optimum productivity of venison production from rusa stags.

ACKNOWLEDGEMENTS

The authors thank Mr. J. McCosker for castrating the stags, Mr. M. Haynes and Mr. R. McAllister for technical assistance, and Mr. A. Lisle for statistical advice.

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