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Results of Breeding Soundness Evaluations of Senepol Bulls in the US Virgin Islands

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Summary

The Breeding Soundness Evaluation (BSE) was used to evaluate Senepol bulls on St. Croix over a 7-yr period. One set of bulls (SELECT; n = 71) was tested prior to sale or use in the breeding herd at various times over the years. The second group of bulls (UNSELECT; n = 491) was tested at 4-mo intervals beginning in November 1998 without any prior selection. Bulls in the SELECT and UNSELECT groups ranged in age from 12.7 to 89.3 mo and 6.5 to 86 mo, respectively. Bulls were given a rating of satisfactory or unsatisfactory based the BSE guidelines. Inbreeding coefficients were determined for a subset of the UNSELECT bulls (n = 316). Data were analyzed using GLM and chi-squared procedures of SAS. In the UNSELECT group the percentage of bulls passing the BSE increased ($P < 0.0001$) with age. There was no change ($P > 0.10$) in percentage passing the BSE with age in the SELECT bulls. In the UNSELECT group, bulls that passed the BSE had larger scrotal circumference, greater sperm motility and a higher percentage of normal sperm ($P < 0.0001$) than bulls that failed. In the SELECT group, bulls that passed the BSE had a higher percentage of normal sperm ($P < .0001$) and motile sperm ($P < 0.03$) but there was no difference ($P > .10$) in SC. The proportion of bulls that failed the BSE but received a passing rating for SC decreased ($P < 0.0008$) with age in UNSELECT but not in SELECT bulls. There was no difference ($P > 0.10$) across ages in the proportion within SELECT or UNSELECT bulls that failed the BSE but received a passing rating for motility or morphology. In the 259 bulls that were tested more than once, there were increases in SC ($P < 0.0001$) and sperm motility and morphology ($P < 0.04$) over time. Inbreeding coefficient was higher ($P < 0.04$) in bulls that failed the BSE than in those that passed (2.36 ± 0.16 vs 1.49 ± 0.38 %, respectively). There was a tendency for bulls with uneven testicles to have a higher ($P = 0.07$) inbreeding coefficient (3.01 ± 0.44 vs 2.19 ± 0.11 %, respectively). Even in the closed herds found on St. Croix the level of inbreeding has been kept to a low level and has not had a negative effect on bull fertility evaluations. The results of the BSE tests indicate that sperm morphology had a greater impact on the proportion of Senepol bulls passing the BSE than did testicular size or sperm motility.

Introduction

The Breeding Soundness Evaluation (BSE; Society for Theriogenology, 1976; Chenoweth et al., 1992) has been used as a classification tool for selecting bulls by several researchers and in many of the beef cattle breeds available today. The threshold levels of SC and semen traits were established using Continental and English breeds of *Bos taurus* cattle. In some cases the minimum SC is not the same across breeds. Bruner et al. (1995) reported that Simmental bulls had a larger SC than Angus, Charolais and Polled Hereford bulls at 11-15 mo of age. Even with the differences in SC there were no differences among breeds in BSE score (Bruner et al., 1995)

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using the older BSE scoring system. This would indicate that there was variation in the semen quality of the bulls that compensated for the differences in SC.

The BSE is a relatively simple and rapid method of evaluating the potential of a bull to be used as a herd sire (Society for Theriogenology, 1976; Chenoweth et al., 1992, 1993). The BSE consists of two components, scrotal circumference (SC) and semen quality. Semen quality is further broken down into progressive motility and sperm morphology. In an early version of the BSE (Society for Theriogenology, 1976) points were assigned for each trait and a bull was assigned a total score, which was the sum of points for each trait. A score of 70 or greater was considered Satisfactory, and bulls that scored below 70 were considered Unsatisfactory. The BSE has since been revised by the Society for Theriogenology (Chenoweth et al., 1992,1993) and now utilizes minimum acceptable levels of each trait to evaluate a bull instead of assigning points for each trait. A minimum scrotal circumference was established for age categories, with the lowest being 30 cm at 12 to 15 mo of age. Sperm morphology must be at least 70% normal with at least 30% progressive motility. For a bull to be classified as a Satisfactory Potential Breeder it must meet or exceed the minimum requirements for each trait. Bulls that do not meet or exceed these threshold values are classified as Unsatisfactory Potential Breeders or Classification Deferred (Chenoweth et al., 1992,1993). When a bull does not meet the minimum semen requirements it is possible to re-test the bull at a later date.

Senepol cattle raised on St. Croix are marketed as breeding animals and are sold as such, in both the domestic and international markets. The ability to select bulls at an early age would be economically beneficial to the cattle producers on St. Croix. Younger bulls that do not meet the minimum selection criteria can be sold for meat in the local market. Bull selection involves the evaluation of several aspects. A bull must have the desired pedigree, breed conformation, and adequate testis size and semen quality. The owner in most cases can readily evaluate both the pedigree and the breed conformation. Testes size and semen quality evaluations require specialized equipment that most cattle producers do not have.

By utilizing the Breeding Soundness Evaluation (BSE) as a selection tool it is possible to remove bulls that do not meet the minimum standards for a breed. Much of the developmental work done with the BSE was done in *Bos taurus* breeds in the United States and may not apply to the Senepol cattle raised under the semi-arid tropical conditions found on St. Croix.

This project evaluated Senepol bulls using the BSE in order to determine the proportion of bulls that pass the BSE at various ages. The level of inbreeding within the closed herds on St. Croix was also determined. Analysis was done to determine if there was a relationship between the BSE results and inbreeding in the Senepol bulls.

Materials and Methods

Senepol bulls on 3 farms on St. Croix, USVI were used and evaluated using the Breeding Soundness Evaluation (BSE) as described by the Society for Theriogenology (Chenoweth et al., 1992,1993). Data was collected over a 7-yr period from bulls ranging in age from 12.7 to 89.3 mo (SELECT; n = 71) for a total of 102 BSE tests. These bulls were evaluated prior to sale or used for breeding at various times over the years at the request of the owner. A second group of bulls aged 6.5 to 86 mo (UNSELECT; n = 491) was tested at 4-mo intervals beginning in November 1998 without any prior selection for a total of 928 BSE tests. Bulls were given a rating of satisfactory or unsatisfactory based the BSE guidelines (Chenoweth et al., 1992,1993).

Measurements collected included scrotal circumference (SC) and sperm motility and morphology. Semen was collected by electroejaculation and evaluated for motility, concentration, normal morphology and % live cells (Godfrey et al., 1990). If a bull had a SC less than the minimum 30 cm necessary for a Satisfactory rating as prescribed in the BSE guidelines semen was not collected. This was done because the bull would not have received a Satisfactory rating, due to small SC, regardless of the semen quality ratings. Inbreeding coefficients were determined for a subset of the UNSELECT bulls (n = 316) using Pedigree Viewer 5.0 software.

Data were analyzed using General Linear Models procedures of SAS (1996) to determine means (± SEM) for BSE traits at various ages and correlation analysis was done to determine the relationship between BSE results and inbreeding level of bulls. Chi-squared analysis was used to analyze the proportions of bulls within age and SELECT vs UNSELECT groups that received Satisfactory or Unsatisfactory BSE ratings.

Results and Discussion

In the UNSELECT group the percentage of bulls passing the BSE was different ($P < 0.0001$) among ages, ranging from 1.5 to 47.1 % (Figure 1). However, there was no difference ($P > 0.10$) in percentage passing the BSE among ages in the SELECT bulls where the passing rate ranged between 73 and 80 %. When both groups were combined there was still a difference ($P < 0.0001$) in the percentage of bulls receiving a Satisfactory BSE rating among the age groups (Figure 1). The percentage of bulls that passed the BSE increased from 1.5 to 62.6 %. Chenoweth et al. (1996) also showed that Senepol bulls in Florida exhibited an increase in the percentage passing the BSE with increases in age. They reported that as the bulls aged 15, 18 or

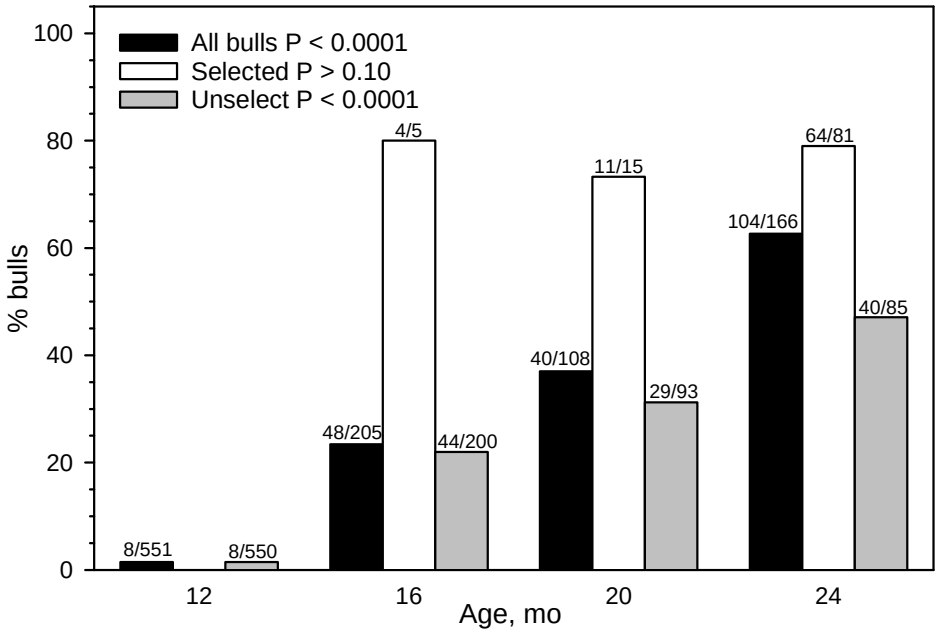

Figure 1. Proportion of Selected, Unselected and All Senepol bulls of various ages that received a Satisfactory BSE rating. The numbers at the top of each bar represent the number of bulls out of the total in that group that received a Satisfactory rating.

21 mo had Satisfactory BSE ratings of 16, 59 and 74 %, respectively. In a study by Wildeus and Fugle (1987) young Senepol bulls at 12, 16, 20 and 24 mo of age had SC of 27, 30, 33 and 35 cm. These values are similar to those of the present study where bulls at 12, 16, 20 and 24 mo had SC of 25, 31, 33 and 38 cm. Larsen et al. (1990) reported that 2 yr old Senepol bulls had an average SC of 34.7 cm and Senepol bulls older than 3 yr had a mean SC of 37.9 cm. These numbers are similar to those reported for bulls of others *Bos taurus* breeds similar in age and also agree with the data of Wildeus (1993) and the data of the present study for Senepol bulls.

There have been breed differences reported when using the BSE to evaluate bulls. Chenoweth et al. (1996) compared BSE test results of Brahman, Angus, Hereford and Senepol bulls and found that Brahman bulls had lower passing rates than the *Bos taurus* breeds at similar ages. Senepol sired calves had larger testes at weaning than did Brahman or Tuli sired calves according to the results of Browning et al. (1997). Tuli cattle are a mix of *Bos taurus* and *Bos indicus* cattle and had intermediate values between Senepol and Brahman sired calves. These results agree with the conclusions of Wildeus (1993) that Senepol bulls are more similar to *Bos taurus* bulls, even though they are tropically adapted similarly to *Bos indicus* cattle.

In the UNSELECT group, bulls receiving a Satisfactory BSE rating had larger SC, higher percentages of motile and normal sperm ($P < 0.0001$) than bulls that failed (Table 1) at all ages tested. In the SELECT group, bulls that passed the BSE had a higher percentage of normal sperm ($P < .0001$) and motile sperm ($P < 0.03$) but there was no difference ($P > .10$) in SC Table 2). The only difference in SC was in the 20 mo old bulls ($P < 0.006$). There was no difference ($P > 0.10$) in percent motile sperm between the 16 or 20 mo old bulls based on BSE result also. In the 259 bulls that were tested more than once, SC ($P < 0.0001$), sperm motility and morphology ($P < 0.04$) increased with age (Table 3).

The proportion of bulls receiving an Unsatisfactory BSE score but received a Satisfactory score for SC decreased ($P < 0.0008$) by age in UNSELECT but not in SELECT bulls (Figure 2).

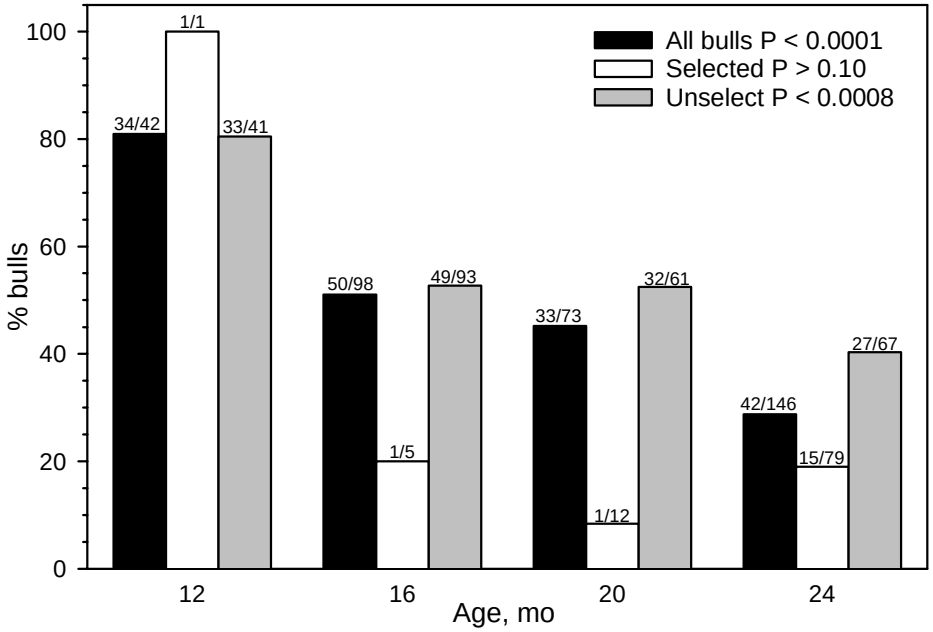

Figure 2. Proportion of bulls that received an Unsatisfactory BSE rating but received a satisfactory rating for the scrotal circumference component of the BSE. The numbers at the top of each bar represent the number of bulls out of the total in each group.

Table 1. Traits of Unselected Senepol bulls based on results of the BSE

Age (mo)	SC (cm)		Motility (%)		Normal Morphology (%)	
	Satisfactory	Unsatisfactory	Satisfactory	Unsatisfactory	Satisfactory	Unsatisfactory
12	33.6 ± 1.1^{a}	24.9 ± 0.1^{b}	80.0 ± 7.6^{c}	61.5 ± 4.8^{d}	81.9 ± 3.8^{a}	56.1 ± 2.4^{b}
16	33.4 ± 0.4^{a}	29.9 ± 0.3^{b}	84.4 ± 3.2^{e}	69.1 ± 2.8^{f}	80.9 ± 1.6^{a}	66.3 ± 1.4^{b}
20	35.1 ± 0.6^{a}	32.0 ± 0.4^{b}	85.6 ± 3.9	80.1 ± 3.2	83.5 ± 1.9^{a}	63.7 ± 1.6^{b}
≥ 24	38.6 ± 0.5^{a}	35.3 ± 0.5^{b}	85.5 ± 3.4	77.3 ± 3.3	84.8 ± 1.7^{a}	63.6 ± 1.6^{b}
Pooled	35.5 ± 0.4^{a}	27.1 ± 0.2^{b}	84.8 ± 1.9^{a}	73.3 ± 1.6^{b}	82.9 ± 0.9^{a}	63.7 ± 0.8^{b}

Values within a trait and age with different superscripts differ: $^{a,b}P < 0.0001$, $^{c,d}P < 0.04$, $^{e,f}P < 0.0004$.

Table 2. Traits of Selected Senepol bulls based on results of the BSE

Age (mo)	SC (cm)		Motility (%)		Normal Morphology (%)	
	Satisfactory	Unsatisfactory	Satisfactory	Unsatisfactory	Satisfactory	Unsatisfactory
12	----	38.6	----	70	----	64
16	36.3 ± 1.8	33.0 ± 3.5	69.0 ± 9.8	85.0 ± 19.6	81.0 ± 4.5^{g}	50.0 ± 8.8^{h}
20	34.9 ± 1.1^{a}	29.2 ± 1.8^{b}	88.0 ± 5.9	75.0 ± 9.8	85.6 ± 2.3^{g}	61.5 ± 4.4^{h}
≥ 24	39.7 ± 0.4	39.8 ± 0.9	81.8 ± 2.5^{c}	67.9 ± 5.2^{d}	83.5 ± 1.1^{g}	61.2 ± 2.4^{h}
Pooled	38.8 ± 0.5	37.6 ± 0.9	81.9 ± 2.4^{e}	70.3 ± 4.7^{f}	83.7 ± 1.2^{i}	60.8 ± 2.4^{j}

Values within a trait and age with different superscripts differ: $^{a,b}P < 0.006$, $^{c,d}P < 0.04$, $^{e,f}P < 0.03$, $^{g,h}P < 0.002$, $^{i,j}P < 0.0001$.

Table 3. Traits of Senepol bulls with more than one BSE test

Age (mo)	SC (cm)	Motility (%)	Normal Morphology (%)
12	29.1 ± 0.8^{a}	67.8 ± 5.5^{e}	67.3 ± 3.4^{e}
16	32.5 ± 0.3^{b}	$78.9 \pm 2.4^{e,f}$	70.1 ± 1.5^{e}
20	34.2 ± 0.4^{c}	82.5 ± 2.5^{f}	$72.8 \pm 1.5^{e,f}$
≥ 24	35.9 ± 0.4^{d}	80.7 ± 2.3^{f}	75.4 ± 1.4^{f}

Values within a trait with different superscripts differ $^{a,b,c,d}P < 0.0001$, $^{e,f}P < 0.04$.

There was no difference ($P > 0.10$) across ages in the proportion within SELECT or UNSELECT bulls that received an Unsatisfactory BSE rating but received a Satisfactory rating for either motility or morphology (Figures 3 and 4). These data indicate that sperm morphology had more impact on whether or not a bull received a Satisfactory BSE rating than SC. This shown by the fact that higher percentages of bulls that received Unsatisfactory BSE rating received Satisfactory SC and sperm motility ratings than Satisfactory ratings for sperm morphology.

Larsen et al. (1990) also noted that the semen component of the BSE was a better predictor of fertility in bulls with a SC greater than the threshold value (32 cm; based on older BSE guidelines Chenoweth, 1993). Carson and Wenzel (1997) found that 71% of Senepol bulls tested, regardless of age, passed the BSE, with 98% having adequate SC and 76% and 98% having adequate sperm morphology and motility, respectively.

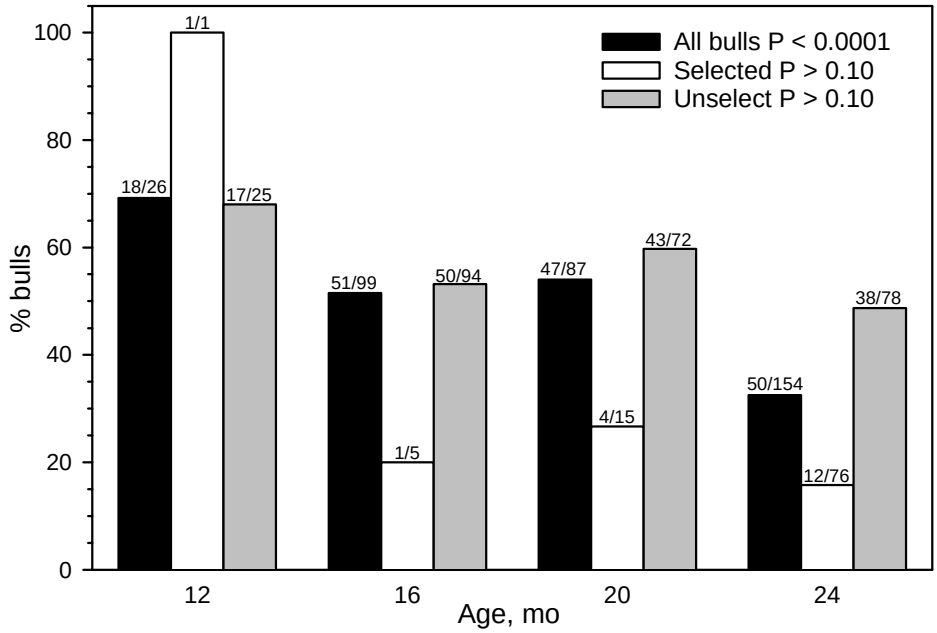

Figure 3. Proportion of bulls that received an Unsatisfactory BSE rating but received a satisfactory rating for the sperm motility component of the BSE. The numbers at the top of each bar represent the number of bulls out of the total in each group.

Larsen et al. (1990) have reported that BSE score was positively correlated with the 21-day conception rate in a cowherd across several breeds. But within the individual breeds tested, there was no relationship between BSE score and fertility detected. There were significant relationships between sperm motility and morphology, two components of the BSE, and fertility traits of the cowherd though (Larsen et al., 1990). These results indicate that semen quality traits are better predictors of fertility than SC alone. But since it has been shown that there is a relationship, although at a low level, between SC and semen quality (Gipson et al., 1985; Godfrey et al., 1988), by selecting for increases in SC there should also be improvements in semen quality. Godfrey et al. (1988) have demonstrated this relationship in Santa Gertrudis bulls.

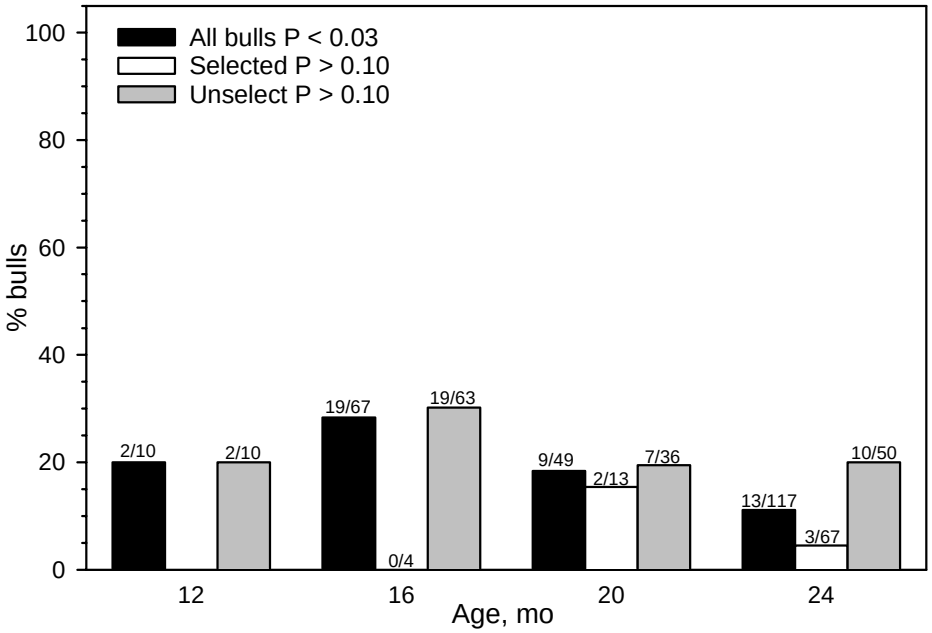

Figure 4. Proportion of bulls that received an Unsatisfactory BSE rating but received a satisfactory rating for the sperm morphology component of the BSE. The numbers at the top of each bar represent the number of bulls out of the total in each group.

Neville et al. (1988) reported that calving rate was positively correlated with motility score of the BSE in bulls. Even with the results of the BSE for a given bull, there is still variation in bull fertility. Only 60% of the fertility can be accounted for by semen evaluation with the remainder being partially due to the cow (Neville, et al., 1988). It was reported that the BSE can identify poor bulls, but other tests are needed to identify the exceptional bulls. In another study Thompson and Johnson (1995) reported that SC alone is not enough to predict the breeding potential of a bull. The semen evaluation is critical because it can be used to determine pubertal status and is also an indicator of testicular health and function (Thompson and Johnson, 1995).

Inbreeding coefficient was higher ($P < 0.04$) in bulls that failed the BSE than in those that passed (2.36 ± 0.16 vs 1.49 ± 0.38 %, respectively). There was no difference among inbreeding coefficients of bulls that received a Satisfactory BSE rating among the age groups tested (Table 4). However, the percentage of bulls receiving a Satisfactory BSE rating increased ($P < 0.0001$) with age in these bulls (Table 4). There was a tendency for bulls with uneven or missing testicles to have a higher ($P = 0.07$) inbreeding coefficient (3.01 ± 0.44 vs 2.19 ± 0.11 %, respectively) than bulls with even testicles. The occurrence of missing or uneven testicles was limited to the 12 and 16 mo old bulls (7.3 and 8.0 5, respectively) with no 20 or 24 mo old bulls exhibiting this characteristic. There was no occurrence of uneven or missing testicles in the SELECT bulls. Bulls with this abnormal trait were culled at an early age and removed from the herds, which explains why they were only detected in the younger, UNSELECT bulls.

Table 4. Inbreeding coefficient (IC) and percentage of Unselected Senepol bulls receiving a Satisfactory BSE by age

Age (mo)	IC (%)	Bulls receiving Satisfactory rating (%)
12	1.74 ± 0.62	1.4[a]
16	2.14 ± 0.25	24.1[b]
20	2.08 ± 0.33	33.8[c]
≥ 24	1.74 ± 0.35	41.3[d]

Values with different superscripts differ: [a,b,c,d]P < 0.0001.

Inbreeding coefficient was negatively correlated with SC (P < 0.002) and sperm motility (P < 0.07) but not sperm morphology (P > .10). There were some variations in these correlations within age groups as well (Table 5). Overall, the inbreeding coefficients were low and did not appear to have a noticeable negative effect on bull fertility traits measured in the BSE test.

Table 5. Correlation of inbreeding coefficient (IC) with BSE traits in Unselected Senepol bulls [a]

	BSE trait		
Age	SC	Motility	Normal Morphology
12	-0.11 (0.04)	-0.42 (0.06)	0.009 (0.97)
16	-0.14 (0.08)	0.002 (0.98)	-0.05 (0.66)
20	-0.21 (0.07)	-0.29 (0.03)	-0.11 (0.43)
24	-0.39 (0.001)	-0.17 (0.19)	0.001 (0.99)
Pooled	-0.12 (0.002)	-0.12 (0.07)	-0.02 (0.77)

[a]Values represent simple correlation coefficient, r, and (P)

Conclusions

A low proportion of young Senepol bulls were able to achieve a Satisfactory BSE rating, but the percentage increased with age, which is in agreement with reports in the literature for other breeds. Scrotal circumference and sperm motility did not appear to have as strong an impact on achieving a Satisfactory BSE rating as sperm morphology did. A higher proportion the bulls that received an Unsatisfactory BSE rating had Satisfactory SC or motility ratings than had Satisfactory morphology ratings. The very low level of inbreeding in the Senepol herds on St. Croix did not have a measurable effect on the breeding potential of the bulls as evaluated using the BSE. It appears that the limited number of Senepol cattle on St. Croix can be managed to

minimize the level of inbreeding an it is not critical to introduce new animals to the herds for breeding. Bull fertility, as indicated by the BSE, can be maintained at an acceptable level within this management system.

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