# Evaluation of the Senepol Breed: Heat Tolerance and Grazing Activity

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## ABSTRACT

Rectal temperature, an index of heat tolerance, was investigated in Senepol, Brahman, Angus and Hereford cows and heifers and Senepol, Hereford and Senepol-Hereford crossbred (S × H and H × S) calves under tropical summer conditions in subtropical central Florida. Grazing activity in Senepol and Hereford cows also was investigated. Rectal temperature was affected by breed in cows, heifers and calves with Angus and Hereford generally displaying higher rectal temperatures than Senepol and Brahman. Hereford calves that were clipped to simulate a short hair coat had rectal temperatures intermediate between Hereford calves with long hair and Senepol calves with short hair. Crossbred Senepol × Hereford calves had a short hair coat similar to purebred Senepol and had rectal temperatures lower than Hereford calves and usually not different than Senepol calves. Mean daily grazing time was similar between years and was longer for Senepol cows (10.5 to 10.7 hours) than for Hereford cows (9.3 hours). Results suggest a higher degree of heat tolerance in Senepol cattle relative to temperate breeds, represented by Angus and Hereford in our study. Furthermore, this heat tolerance may have been responsible for the difference in average daily grazing time observed between Hereford and Senepol cows because rectal temperature was negatively associated with grazing time.

## INTRODUCTION

Efforts to increase efficiency of beef cattle production in the subtropics and other warm, harsh environments are hampered by a number of environmental factors including high ambient temperatures, low forage quality and exposure to diseases and parasites. In the USA, Brahman and various Brahman composite breeds are the main source of beef cattle germ plasm with adaptation to the harsh, warm environments of the south. An easily measured and valid indicator of tropical adaptation is the ability of an animal to maintain a normal body temperature under hot ambient temperature conditions (Finch, 1986). The Brahman, a *Bos indicus* breed, displays lower rectal temperatures than *Bos taurus* breeds when grazing under high ambient temperatures (Cartwright, 1955; Turner, 1984). Long-term selection of Hereford × Shorthorn cattle for growth under a dry tropical environment led to increased heat tolerance (Frisch, 1981), and suggests that *Bos taurus* also can adapt to harsh, warm environments. The Senepol, a *Bos taurus* breed developed on St. Croix, U.S. Virgin Islands, is purported to have been selected for traits that included heat tolerance (Hupp, 1981). No data are available comparing heat tolerance of Senepol to other beef cattle breeds. Therefore, the first objective of this study was to investigate rectal temperature, as an index of heat tolerance, in Senepol, Brahman, Angus, Hereford and crossbred Senepol cattle under tropical summer conditions in the subtropical environment of central Florida. A second objective was to evaluate differences in grazing time between Hereford (temperate *Bos taurus*) and Senepol (tropical *Bos taurus*) cows under the same subtropical environment.

## MATERIALS AND METHODS

These experiments were conducted at the Subtropical Agricultural Research Station near Brooksville, Florida. Coordinates of Brooksville are 28° 33' 30" north latitude and 82° 23' 30" west longitude. The topography is gently rolling hills with the highest elevation on the Station being 276 feet. Average annual rainfall is 54 inches with over half of the rainfall (54%) occurring in June, July, August and September. Average year-round temperature is about 72°F with up to several frosts occurring during November through March.

### Trial 1, Rectal Temperature in Cows

Rectal temperatures were measured at two-week intervals beginning June 21 and ending August 16, 1988 (5 measurement dates) in 30 each of Angus, Brahman, Hereford and Senepol cows. Cows were nursing calves

except for twelve Brahman, two Hereford and one Senepol. Rectal temperature measurements were made with electronic thermometers (Vet III, Advanced Animal Instruments, Inc., Williston Park, New York 11596). Cows were gathered by 10:00 hours at three separate working facilities each within a few kilometers of the others (Angus cows at one location, Brahman cows at one location, and Hereford and Senepol cows at one location). Cows were kept in holding pens with access to shade until concurrent measurements of rectal temperature began at 12:30 hours by personnel at each of the facilities. In addition to rectal temperature, order of cows being handled and body weights (BW) were recorded, and on some dates, blood samples were obtained for a separate experiment. At two of the locations, ambient temperatures were recorded immediately prior to and after working the cows and average ambient temperature was considered to be the mean of these two measurements.

**Trial 2, Rectal Temperature in Heifers**

Rectal temperatures were measured at four-week intervals beginning June 17 and ending August 12, 1988 (3 measurement dates) in 52 Angus, 43 Brahman, 36 Hereford and 24 Senepol heifers ranging in age from about 13 to 17 months. Protocol was the same as described for Trial 1 except that all heifers were managed and handled together at one location. Following measurement of rectal temperature, heifers were palpated rectally for a separate experiment. Order of heifer handling and BW were recorded as in Trial 1. Ambient temperature was recorded before and after working the heifers and average ambient temperatures calculated as in Trial 1.

**Trial 3, Rectal Temperature in Calves**

Rectal temperatures were measured at three-week intervals beginning June 19 and ending August 21, 1990 (4 measurement dates) in 12 Hereford, 12 Senepol, 18 Hereford × Senepol and 16 Senepol × Hereford calves nursing Senepol or Hereford cows. Cows and calves were gathered by 10:00 hours and kept together in holding pens with access to shade until 13:00 hours at which time calves were parted and rectal temperature, order of handling and BW recorded as described for trials 1 and 2. Measurements were taken at one location but cows and calves were managed in two herds defined by breed of service sire, Hereford or Senepol. Both herds were composed of Senepol and Hereford cows. Ambient temperature and humidity were recorded before and after working the calves on each date and average temperature and humidity calculated. After obtaining rectal temperatures on the second date (July 10, 1990), half of the Hereford calves were clipped to simulate a short hair condition. The entire body was clipped close to the skin except for the switch of the tail which was not clipped.

**Trial 4, Grazing Activity**

In association with working of calves in Trial 3, three randomly selected cows from the Senepol service sire herd (2 Senepol, 1 Hereford) and three randomly selected cows from the Hereford service sire herd (2 Hereford, 1 Senepol) were fitted with eight-day vibracorders (Stobbs, 1970) mounted on aluminum collars to measure movement associated with grazing. Recordings of continuous activity of 6 minutes (0.1 hour) or longer were taken to be activity associated with grazing. Difficulty was experienced in obtaining week-long recordings due to malfunction of some of the recorders so grazing time data were pooled within animal across measurement dates. Total mean recording time per cow used in the analysis was 8.5 days. Pastures were predominately bahiagrass (Paspalum notatum) and contained wooded areas for shade.

**Trial 5, Rectal Temperatures and Grazing Activity in Cows**

To confirm the breed effects on grazing activity observed in Trial 4, a second set of experiments, each of 4 days duration, was conducted beginning June 10, July 1, July 29, August 12 and September 9, 1991 with 6 Hereford and 6 Senepol multiparous cows. Half of the Hereford cows and half of the Senepol cows were each part of larger mixed Hereford-Senepol herds that grazed adjacent bahiagrass pastures. Rectal temperatures were recorded at the beginning and end of each four-day experimental period. The procedure used for obtaining rectal temperatures was as described for the previous trials. Grazing activity was measured with vibracorders as described for Trial 4. Ambient temperature and relative humidity were recorded at the beginning and end of each experimental period at the time rectal temperature measurements were made. In addition, black globe temperatures (Buffington et al. 1981) were recorded once

daily during the experimental periods in shade and unshaded areas. For statistical analysis, average temperatures and relative humidity for each experimental period were used. For statistical analysis of grazing time, data were pooled within animal across experimental periods as in Trial 4.

## RESULTS

### Trial 1, Rectal Temperature in Cows

Effects of breed and date on rectal temperature of cows, corrected for effect of order of handling, are given in Table 1. Rectal temperature increased 0.013°F for each cow handled. Average time required to handle one cow was 2.6 minutes. Rectal temperature was affected by breed, date and the interaction between breed and date. Separate analysis of breed effects by date indicated that the interaction was primarily due to higher rectal temperatures of Hereford compared to Brahman on the first, third and fifth measurement dates, and no difference in rectal temperature between Hereford and Brahman on the second and fourth measurement dates. These differences by date did not seem to be explained by date differences in average ambient temperatures which were 77.5°, 84.7°, 86.5°, 80.8° and 82.9°F for the first through the last measurement date, respectively. Throughout Trial 1, Angus cows always had the highest rectal temperatures and Senepol cows the lowest. Cow BW did not change during the eight-week trial. Brahman (1,052 lb) and Hereford (1,027 lb) cows were heavier than Senepol (988 lb) and Angus (979 lb) cows.

### Trial 2, Rectal Temperature in Heifers

Effects of breed and date on rectal temperature of heifers, corrected for effect of order of handling, are given in Table 2. Rectal temperature increased 0.016°F for each heifer handled. Average time required to handle one heifer was 1.6 minutes. Rectal temperature in heifers was affected by breed and date. Angus and Hereford heifers had the highest rectal temperatures, Brahman intermediate and Senepol the lowest. Rectal temperatures measured the first two dates were not different from each other, but both were higher than rectal temperatures measured on the last measurement date. Average ambient temperatures were 86.5°, 83.5° and 86.0°F, respectively. Heifers lost an average of 35 lb during the eight-week trial which likely was associated with a typical decline in forage quality as the summer progressed. Brahman (642 lb) heifers were heavier than Hereford (607 lb) and Angus (603 lb) heifers, but were not different from Senepol (627 lb) heifers; BW of Senepol, Hereford and Angus heifers was not different.

### Trial 3, Rectal Temperature in Calves

Effects of breed and date on rectal temperature of calves for the first two measurement dates are given in Table 3. There was no effect of order of sampling so order was removed from the model used in the final analysis. Rectal temperature was higher in Hereford calves compared to Senepol and the reciprocal- crossbred calves, and was higher on the first measurement date compared to the second. Average ambient temperatures were 82o and 92oF, and average relative humidities were 65% and 48% for the two dates, respectively. Higher humidity, rather than higher ambient temperature, was associated with higher rectal temperatures. Calves gained an average of 2.0 lb/day over the three-week period. Average BW was different among breeds: Hereford × Senepol (425 lb) > Senepol (354 lb) > Senepol × Hereford (332 lb) > Hereford (306 lb).

Effects of breed or clipping treatment and date on rectal temperature of calves for the second two measurement dates, corrected for effect of order of handling, are given in Table 4. Rectal temperature increased 0.016oF for each calf handled. Average time required to handle one calf was 2.1 min. Rectal temperature was affected by breed, date and the interaction between breed and date. Separate analysis of breed effects by date indicated that rectal temperature always was highest in Hereford and lowest in Senepol and Hereford × Senepol calves, and that the interaction was due to the relative ranking of Hereford clipped and Senepol × Hereford calves which was different between dates. Average ambient temperatures were 87° and 83°F, and average relative humidities were 57% and 73% for the two dates, respectively. Unlike the first period of this trial, higher ambient temperature rather than higher humidity was associated with higher rectal temperatures. Calves gained an average of 1.5 lb/day during this three-week period. Breed effects on average BW of calves were the same as for the previous three-week period: Hereford × Senepol (515 lb) > Senepol (438 lb) > Senepol × Hereford (398 lb) > Hereford (367 lb) = clipped Hereford (350 lb).

**Trial 4, Grazing Activity**

Mean daily grazing time was longer for Senepol (10.7 hours) than for Hereford (9.3 hours) cows. Hourly pattern of grazing activity is shown in Figure 1a. When effect of breed on grazing time was analyzed by hour of day, few statistical differences were observed but a trend toward longer grazing times for Senepol during the late morning could be seen (Figure 1a). Conversely, there appeared to be a trend for Hereford cows to graze more at night between 23:00 hours and 03:00 hours, but this was not enough to the compensate for the greater grazing time of the Senepol cows during the daylight hours.

**Trial 5, Rectal Temperature and Grazing Activity in Cows**

Rectal temperature was lower for Senepol than Hereford cows (Table 5). There was no effect of date on rectal temperature. Ambient temperatures, relative humidity, and black globe temperatures for the five experimental periods (dates) are given in Table 6. Black globe temperatures in shade and relative humidities were different among dates with respective ranges (experimental period means) of 86 to 90° F and 54 to 81%. Mean cow BW (983 lb) did not change during the trial and was not different between Hereford and Senepol cows.

Total daily grazing time was longer for Senepol (10.5 hours) than for Hereford (9.3 hours) cows. Senepol cows grazed longer between 09:00 hours and 13:00 hours than Hereford cows, but Hereford cows grazed longer than Senepol cows between 05:00 hours and 08:00 hours (Figure 1b). Total daily grazing time was negatively correlated with rectal temperature across all cows throughout the trial, but the correlation coefficient was small (r = -0.35).

## DISCUSSION

Based on early experiments with small numbers of cows in environmental chambers, Kibler and Brody (1950) reported that critical ambient temperatures resulting in increased rectal temperature in Brahman cows were higher (90o to 95oF) than for Jersey and Holstein cows (70o to 80oF). Ambient temperatures under which our experiments were conducted averaged 84°F and ranged from 78° to 92°F, and were within or above the critical range suggested by Kibler and Brody (1950) for "European-evolved" cows. As expected, Angus and Hereford cows and heifers displayed higher rectal temperatures than Brahman cows and heifers in our experiments. Others reporting lower rectal temperature in Brahman cattle compared to temperate cattle breeds include Cartwright (1955), Seif et al. (1979) and Turner (1984). An unexpected result was that Senepol cows and heifers displayed lower rectal temperatures than Brahman cows and heifers. These differences may have been the result of the difference in temperament between Brahman and Senepol, Brahman being more excitable relative to the more docile Senepol. We are aware of only one study in which rectal temperatures of Senepol cattle were measured (Wildeus, 1987). In this study, Senepol bulls had lower rectal temperatures than Holstein bulls under ambient conditions of 82°F and 82% relative humidity on St. Croix.

Effects of coat type (hair length) were investigated with Hereford and Senepol calves in Trial 3. The Senepol and reciprocal crossbred calves had short hair coats. Rectal temperatures of the crossbred calves were not different from Senepol calves or were intermediate between Senepol and Hereford calves. In the middle of Trial 3, half of the Hereford calves were clipped to simulate a short hair coat. Clipped Hereford calves displayed rectal temperatures intermediate between Hereford and Senepol calves, suggesting that factors in addition to coat type are involved in the heat tolerance displayed by the Senepol. Yeates (1955) used controlled lighting to produce short-haired and long-haired conditions in Shorthorn cattle that resulted in increased rectal temperature with the long-haired condition at an ambient temperature of 105°F. Clipping of the long-haired cattle resulted in rectal temperatures equal to that of short-haired controls. Similarly, Turner (1962) found that clipping Hereford and Shorthorn calves reduced rectal temperatures and increased growth rate in summer at the Belmont Cattle Breeding Station in Queensland, Australia. Dowling (1956) showed that, under heat stress, coat type among Shorthorn bulls was associated with rectal temperature, and Turner and Schleger (1960) showed strong correlations between coat score and rectal temperature in zebu and European cattle at Belmont. In addition to coat type or hair length, variation in heat tolerance of cattle has been associated with coat color

(Finch et al., 1984; Hansen, 1990), sweating ability (Dowling, 1958; Finch et al., 1982), variation in heat production (Kibler, 1957; Johnston et al., 1958) and differences in non-evaporative heat transfer (Finch, 1985). Which of these factors are involved in the relatively high heat tolerance displayed by the Senepol breed cannot be determined from the present data.

Senepol cattle are noted for their tendency to graze at hot times during the day when temperate breeds are observed standing or laying in shade. This is consistent with our observations at Brooksville. Trials 4 and 5 were conducted to determine whether these perceived differences in grazing behavior were quantitatively significant and, therefore, associated with the demonstrated differences in heat tolerance between Hereford and Senepol. Senepol cows grazed an average of 10.7 hours/day in Trial 4 and 10.5 hours/day in Trial 5 which was an average of 1.3 hours/day longer than for Hereford cows. Daily grazing time for Hereford cows in our study was 9.3 hours/day in both trials, slightly above average daily grazing times reported by Stricklin et al. (1976) for Charolais-Angus crossbred cows (9.0 hours/day) and Angus cows (8.5 hours/day) grazing summer pasture in Pennsylvania. Grazing times measured in our study were within the range of times measured by Stobbs (1970) for Jersey cows grazing tropical legumes (10.8 hours/day) or tropical grasses (8.5 hours/day) in southeastern Queensland, and were similar to grazing times measured for "Grade and Zebu" steers (9.5 hours/day) under tropical conditions reported by Lampkin and Quarterman (1962).

The ability of Senepol cattle to maintain rectal temperature near 102°F during summer in the hot, humid environment of central Florida demonstrates a higher degree of heat tolerance relative to temperate breeds, represented by Angus and Hereford in our study. Based on differences in rectal temperature among breeds in this study, the heat tolerance displayed by Senepol cattle was similar (if not superior) to that of Brahman. Difference in heat tolerance may have been responsible for the difference in average daily grazing time we observed between Hereford and Senepol cows. Furthermore, the relative degree of heat tolerance observed in crossbred Senepol calves in this study suggests that this trait displays some dominance and will be useful to producers interested in increasing heat tolerance in temperate-type cattle by crossing with Senepol.

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**TABLE 1. Effects of breed and date of measurement on rectal temperature (°F) of cows[a,b] (Trial 1).**

| | Breed | | | | |
|---|---|---|---|---|---|
| **Date** | **Angus** | **Brahman** | **Hereford** | **Senepol** | **Mean** |
| **21 JUN 88** | **103.5** | **102.6** | **102.8** | **102.2** | **102.8[e]** |
| **05 JUL 88** | **103.6** | **102.2** | **102.3** | **102.0** | **102.5[f]** |
| **19 JUL 88** | **104.8** | **102.9** | **103.5** | **102.1** | **103.4[d]** |
| **02 AUG 88** | **105.0** | **102.9** | **102.4** | **101.8** | **103.0[e]** |
| **16 AUG 88** | **105.2** | **103.0** | **103.5** | **102.5** | **103.5[c]** |
| **Mean** | **104.4[c]** | **102.7[e]** | **102.9[d]** | **102.1[f]** | |

[a] Breed by date interaction ($P < 0.01$).
[b] Data are least-squares means.
[cdef] Means in the same row or in the same column without common superscripts differ ($P < 0.01$).

**TABLE 2. Effects of breed and date of measurement on rectal temperature (°F) of heifers[a].**

| | Breed | | | | |
|---|---|---|---|---|---|
| **Date** | **Angus** | **Brahman** | **Hereford** | **Senepol** | **Mean** |
| 17 JUN 88 | 104.0 | 102.7 | 103.9 | 102.4 | 103.2[b] |
| 15 JUL 88 | 104.1 | 103.2 | 103.9 | 102.3 | 103.4[b] |
| 12 AUG 88 | 103.7 | 103.0 | 103.7 | 102.1 | 103.1[c] |
| MEAN | 103.9[d] | 102.9[e] | 103.8[d] | 102.3[f] | |

[a] Data are least-squares mean.
[bc] Means in the same column without common superscripts differ ($P < 0.05$).
[def] Means in the same row without common superscripts differ ($P < 0.01$).

**TABLE 3. Effects of breed and date of measurement on rectal temperature (°F) of calves[a].**

| Breed | | | | | |
|---|---|---|---|---|---|
| **Date** | **Hereford** | **H × S[b]** | **S × H[c]** | **Senepol** | **Mean** |
| 19 JUN 90 | 105.6 | 103.8 | 103.6 | 103.4 | 104.1[d] |
| 10 JUL 90 | 104.6 | 103.4 | 103.4 | 103.2 | 103.7[e] |
| Mean | 105.1[d] | 103.6[e] | 103.5[e] | 103.3[e] | |

[a] Data are least-squares means.
[b] Hereford × Senepol.
[c] Senepol × Hereford.
[de] Means in the same row or in the same column without common superscripts differ (P < 0.01).

**TABLE 4. Effects of breed or clipping treatment and date of measurement on rectal temperature (°F) of calves[ab].**

| Breed or Treatment | | | | | | |
|---|---|---|---|---|---|---|
| **Date** | **Hereford** | **Hereford (clipped)** | **H × S[c]** | **S × H[d]** | **Senepol** | **Mean** |
| 31 JUL 90 | 105.7 | 104.8 | 103.8 | 103.4 | 102.9 | 104.1[e] |
| 21 AUG 90 | 103.8 | 103.2 | 102.8 | 103.8 | 103.1 | 103.3[f] |
| Mean | 104.7[e] | 104.0[f] | 103.3[gh] | 103.5[fg] | 103.0[h] | |

[a] Breed or clipping treatment by date interaction (P < 0.01).
[b] Data are least-squares means.
[c] Hereford × Senepol.
[d] Senepol × Hereford.
[efgh] Means in the same row or in the same column without common superscripts differ (P < 0.01).

**TABLE 5. Effects of breed and date of measurement on rectal temperature (°F) of cows[a] (Trial 5).**

| | Breed[b] | | |
|---|---|---|---|
| Date[c] | Hereford | Senepol | Mean |
| 10 JUN 91 | 102.9 | 102.1 | 102.5 |
| 01 JUL 91 | 103.2 | 102.1 | 102.7 |
| 29 JUL 91 | 103.2 | 102.3 | 102.8 |
| 12 AUG 91 | 103.4 | 101.8 | 102.6 |
| 09 SEP 91 | 103.5 | 101.9 | 102.7 |
| Mean | 103.2 | 102.1 | |

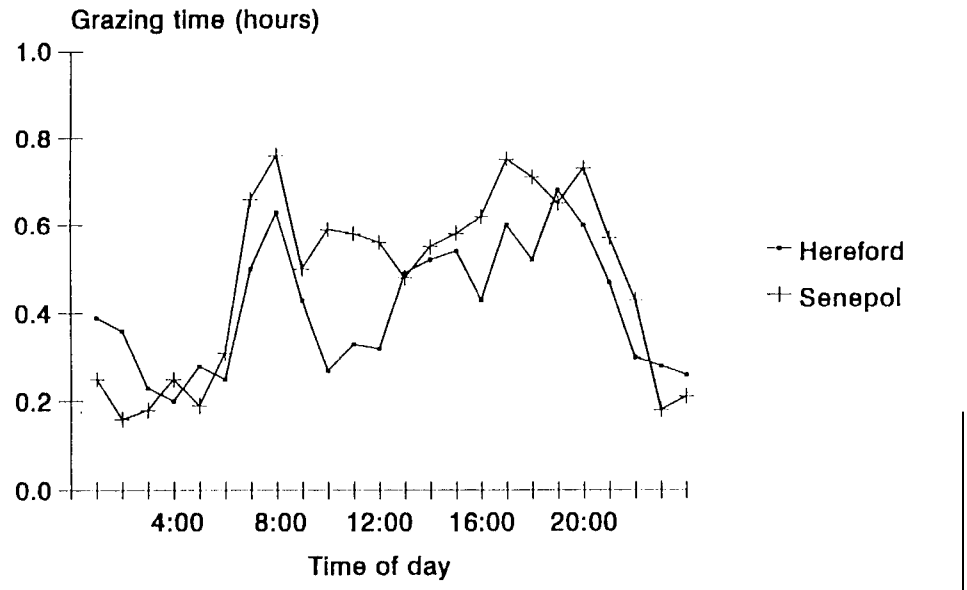
[a] Data are least-squares means.
[b] Breed effect ($P < 0.01$).
[c] Date effect ($P > 0.10$).

**TABLE 6. Ambient temperatures, relative humidity and black globe temperatures (Trial 5).**

| Date | Ambient temperature, °F | Relative humidity, % | Black globe temperature in shade, °F | Black globe temperature unshaded, °F |
|---|---|---|---|---|
| 10 JUN 91 | 87 | 59[a] | 91[ab] | 106 |
| 01 JUL 91 | 86 | 81[b] | 88[b] | 96 |
| 29 JUL 91 | 91 | 68[ab] | 86[b] | 98 |
| 12 AUG 91 | 91 | 54[a] | 89[b] | 100 |
| 09 SEP 91 | 90 | 56[a] | 99[a] | 112 |

[ab]Means in the same column without a common superscript differ ($P < 0.05$).

**(a)**




**(b)**

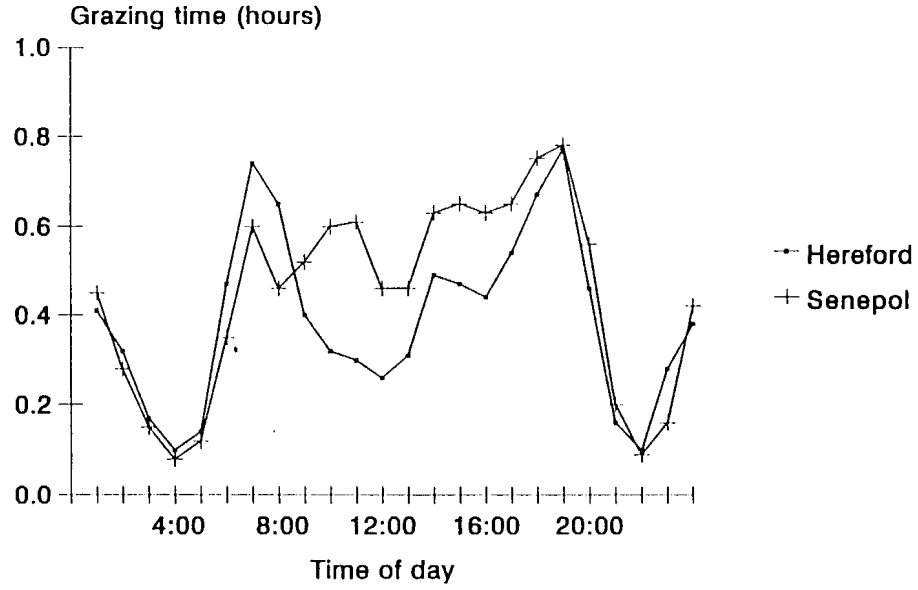



Figure 1. Effects of breed of cow, Hereford, vs. Senepol, on average grazing time by hour of day; (a) Trial 4, summer 1990 and (b) Trial 5, summer 1991.