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Different evaluation methods of Canchim cattle temperament

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Abstract – The objective of this work was to evaluate the temperament of Canchim calves using different methods, to compare these methods, and to determine the most suitable for commercial use. The temperament of 1,831 calves was evaluated at 15 days after weaning by visually analyzing movement, tension, breathing, vocalizing, and kicking. Measurements were taken at 10 and 20 s after the calf entered the scale. The reactivity score was determined electronically, and flight speed was measured after the calf left the scale. The results of the principal component analysis showed that the first component explained 40.27% of total variation. Positive correlations were found for tension at 10 and 20 s, movement at 10 and 20 s, and reactivity score, with correlation coefficients ranging from 0.60 to 0.88. Temperament and reactivity scores presented moderate correlations of 0.25 and 0.35, respectively, with flight speed. However, kicking had no correlation with any variable. No differences were observed for reactivity measured at 10 or 20 s. The visual evaluations of movement and tension or of reactivity through an electronic device can be used for temperament evaluation of Canchim calves.

Index terms: *Bos taurus*, beef cattle, behavioral responses, composite breed, principal components.

Diferentes métodos de avaliação do temperamento de bovinos Canchim

Resumo – O objetivo deste trabalho foi avaliar o temperamento de bezerros da raça Canchim por meio de diferentes métodos, comparar estes métodos e determinar o mais adequado para uso comercial. O temperamento de 1.831 bezerros foi avaliado 15 dias após a desmama, tendo-se analisado visualmente deslocamento, tensão, respiração, vocalização e coice. As medidas foram feitas aos 10 e 20 s após o bezerro entrar na balança. A reatividade foi determinada eletronicamente, e a velocidade de saída foi medida após o bezerro sair da balança. O resultado da análise de componentes principais indicou que o primeiro componente explicou 40,27% da variação total. Foram verificadas correlações positivas para tensão aos 10 e 20 s, deslocamento aos 10 e 20 s, e reatividade, com coeficientes de correlação de 0,60 a 0,88. Os escores de temperamento e reatividade apresentaram correlação moderada de 0,25 e 0,35, respectivamente, com velocidade de saída. No entanto, coice não se correlacionou com nenhuma variável. Não foi observada nenhuma diferença para reatividade medida aos 10 ou 20 s. As avaliações visuais de deslocamento e tensão ou da reatividade por dispositivo eletrônico podem ser utilizadas na avaliação de temperamento de bezerros Canchim.

Termos para indexação: *Bos taurus*, bovinos de corte, respostas comportamentais, raça composta, componentes principais.

Introduction

Temperament is a complex and hard-to-define characteristic, combining several aspects of animal behavior such as curiosity, shyness, aggressiveness, hesitation, fear, desire to take chances and explore, sociability, and nervousness, among others, which have been studied by several authors (Sant'Anna et al., 2013; Finkemeier et al., 2018; Brandão & Cooke, 2021).

Regarding beef cattle, studies have shown that animals with a more reactive behavior presented a lower grazing performance (Sant'Anna et al., 2013; Della Rosa et al., 2019), lower feedlot results (Braga et al., 2018; Olson et al., 2019), lower carcass quality (Francisco et al., 2015), and negative effects on traits related to meat quality (Olson et al., 2019; Moura et al., 2021). Turner et al. (2013) found that more reactive cows, that is, presenting a high flight speed, produced calves with a lighter birth weight. In addition, temperamental cattle showed a distinct neutrophil function, suggesting special management practices to reduce and prevent stress before and after transportation (Hulbert et al., 2011). Therefore, temperament has an economic importance in animal production, showing the need for its evaluation.

In the literature, heritability has been analyzed for most temperament traits, with values ranging from low to moderate (Sant'Anna et al., 2015; Torres-Vázquez & Spangler, 2016; Titterington et al., 2022), suggesting that these traits have a good potential to be included in multi-trait selection programs. Hine et al. (2019) even suggested that temperament and immune competence traits are genetically correlated.

In cattle breeding, temperament evaluation is frequently associated with animal response to environmental or social stimuli (Haskell et al., 2014; Smolinger & Škorjanc, 2021) and can be carried out using subjective or objective methods, through visual observations or electronic devices, while keeping animals restrained or free (Maffei et al., 2006; Sant'Anna et al., 2013; Cooke at al., 2017; Braz et al., 2020). However, each method captures different aspects of animal behavior and requires unique experimental conditions.

Although cattle reactivity tends to decrease with age depending on management conditions (Schmidt et al., 2014; Peixoto et al., 2016), a suitable strategy for early selection in breeding programs is evaluating temperament at weaning since that characteristic is considered consistent throughout the animal's life (Turner et al., 2011). Excitable calves around weaning, for example, continue to exhibit excitable temperament when they reach breeding age (Kasimanickam et al., 2018).

The Canchim (5/8 Charolais x 3/8 Zebu) composite breed shows potential for use in cattle breeding programs. Canchim is a Brazilian beef cattle breed developed at Embrapa Pecuária Sudeste and officially registered in the 1970's, with an excellent meat yield and quality and good performance when raised on natural pastures in the country (Buzanskas et al., 2017). Although several studies have evaluated this breed in terms of growth, meat quality, nutrition, reproduction, thermoregulation, and genetics (Caetano et al., 2013; Santiago et al., 2017; Romanello et al., 2018; Duarte et al., 2022; Romanello et al., 2023), there is little information in the literature on its temperament traits.

Considering the temperament of the breeds from which Canchim originated, Zebu cattle is generally more excitable than *Bos taurus* cattle (Haskell et al., 2014), whereas, among *B. taurus*, some genetic variants of European Continental breeds are more excitable than British breeds (Haskell et al., 2014). Charolais calves were found to be more nervous than calves of the Aubrac French beef cattle breed (Kosztolányiné et al., 2018). Therefore, it is important to understand the dynamics of this trait in the composite Canchim breed.

The objective of this work was to evaluate the temperament of Canchim calves using different methods, to compare these methods, and to determine the most suitable for commercial use.

Materials and Methods

The study was approved by the animal ethics committee on animal use of Embrapa Pecuária Sudeste, under protocol number CEUA 03/2014.

The experiment was carried out at Fazenda Canchim, a research facility of Embrapa Pecuária Sudeste, located in the municipality of São Carlos, in the state of São Paulo, Brazil (21°57'42"S, 47°50'28"W, at an altitude of 860 m above sea level). The evaluations were conducted between 2013 and 2020, using a sample consisting of 1,831 animals, of which 958 were males and 873 were females. An average of 228.9 calves were evaluated per year, and a total of 4,852 measurements were carried out about 15 days after weaning.

All animals were raised exclusively in pastures with ad libitum access to mineral supplements and, then, taken to corrals with holding pens for evaluation. On the day before the evaluation, animal batches were brought to the paddocks near the corrals. During the evaluation, there was no immobilization of the animal, direct contact with it, or any other simultaneous procedure.

The animals were confined to a weight scale for temperament evaluations through reactivity traits, objective reactivity score, and flight speed. The reactivity traits movement, tension, breathing, vocalizing, and kicking were evaluated visually. Two scores were attributed by one observer at 10 and 20 s after the calves stepped on the scale. Five behavior categories were evaluated (Table 1), based on a visual metric adapted from Ceballos et al. (2016).

The objective reactivity score was determined using the REATEST accelerometer device developed by Maffei et al. (2006), but not yet commercially available, coupled to the scale. The measurement was taken while calves were kept on the scale for 20 s. A score between 1 and 99,999 was attributed to the intensity and frequency of calf movements. The objective reactivity score mean and standard error were calculated.

Flight speed was considered the time the animal took to cover a distance of 2.70 m after leaving the scale, measured using the Duboi photoelectric sensor (Duboi Indústria e Comércio Ltda, Campo Grande, MS, Brazil), following the methodology adapted from Burrow et al. (1988). Flight speed mean and standard error were calculated.

The IBM SPSS, version 23 (IBM, São Paulo, SP), was used to carry out the principal components analysis. Data were checked for linearity using Spearman's correlation matrix, at α=0.01. Multicollinearity was checked using the variance inflation factor. Since the variables were measured in different scales, they were standardized using a correlation matrix, equivalent to a matrix of a standardized variable (Johnson & Wichern, 1998). The correlation matrix was chosen rather than a covariance one because it smooths possible sharp discrepancies between variances and allows comparing the eigenvectors of a component.

The principal component model considered the correlation matrix without rotation. The relative importance of a principal component was evaluated through the percentage of the total variance that this component explains. The criterion used for discarding variables was based on the recommendations of Jolliffe (1972), who suggests that the number of discarded variables must be equal to the number of principal components with a variance (eigenvalue) below 0.70.

Table 1. Description of the criteria used to visually evaluate and classify reactivity traits of Canchim (5/8 Charolais x 3/8 Zebu) cattle.

Trait	Category	Criteria
Movement	1	No movement
	2	Few movements for less than half of the observation time
	3	Frequent but not vigorous movements for half of the observation time or more
	4	Constant and vigorous movements
	5	Constant and vigorous movements, characterized by the animal jumping and raising its forelimbs off the ground
Tension	1	No sudden movements of tail, head and neck; no muscle tremors; and eye whites not visible
	2	Few sudden movements of tail, head and neck; no muscle tremors; and eye whites visible or not
	3	Continuous and vigorous movements of tail, head and neck; no muscle tremors, and eye whites visible
	4	Paralyzed or "frozen", visible muscle tremors
Breathing	1	Normal, rhythmic, and non-audible breathing
	2	Easily audible breathing, or puffing and blowing, but not rhythmic
Kicking	1	No vigorous blow with hind foot
	2	Vigorous blow with hind foot
Vocalization	1	Absence of vocalization
	2	Occurrence of bellowing or mooing regardless of frequency or intensity

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Results and Discussion

The frequency distribution of the evaluated temperament variables is shown in Table 2. Kicking and vocalization presented a very low relative frequency of < 5.0%. Flight speed results varied from 0.40 to 4.36 m s^{-1} to cover 2.70 m, with a mean of 1.72±0.78 m s^{-1}, which was within the ranges reported in other studies. For Nellore bulls, for example, Sant'Anna et al. (2019) found flight speed means around 1.668±0.712 and 1.488±0.507m s^{-1} depending on the treatment. For the Angus breed, Lees et al. (2020) observed flight speed means of 2.3±0.09 and 1.8±0.07 m s^{-1} for heifers and steers, respectively. For Hereford steers, Costa et al. (2019) obtained a mean flight speed of 0.44±0.19 m s^{-1}, varying from 0.04 to 0.90 m s^{-1}. For steers of the ⅝ Brahman x ⅜ Shorthorn composite breed at weaning, Petherick et al. (2009) found flight speed values of 2.83±0.93, 2.63±0.89, and 2.25±0.86 m s^{-1} in the first, second, and third measurements, respectively. The objective reactivity score at 20 s ranged from 238 to 28,495 points, with a mean of 3,255.28±3,477.18 points. For Nellore yearling cattle, Maffei et al. (2006) reported a lower objective reactivity score of 534±447 points.

The correlation analysis showed a strong and significant association between objective reactivity score and tension and between objective reactivity score and movement (Table 3), with estimated correlations ranging from 0.60 to 0.88 ($p<0.01$). Kicking and vocalization presented a low correlation or no association at all with the other variables. Moreover, flight speed presented a positive and low correlation with movement, tension, breathing, and objective reactivity scores, with values ranging from 0.25 to 0.35. However, flight speed had no correlation with vocalization at 20 s and kicking at 10 and 20 s ($p>0.05$), but a low correlation with vocalization at 10 s ($p<0.01$). Schwartzkopf-Genswein et al. (2012) studied different methods to evaluate the temperament of males of the Angus breed and did not observe a significant correlation between flight speed and crush score, a measurement similar to movement. Piovezan et al. (2013) obtained a correlation of -0.36 between flight speed and a composite temperament score, which would be similar to a variable encompassing movement, vocalization, kicking, and breathing. Burrow & Corbet (2000) did not find an association between a subjective evaluation and flight speed.

Table 2. Absolute frequency and relative frequency by category of the reactivity traits evaluated visually at 10 and 20 s after the Canchim (5/8 Charolais x 3/8 Zebu) calf enters the scale.

Trait	Category	10 seconds		20 seconds	
		Frequency (n)	Relative frequency (%)	Frequency (n)	Relative frequency (%)
Movement	1	793	48.7	706	38.7
	2	505	31.0	757	41.5
	3	211	12.9	242	13.3
	4	82	5.0	74	4.1
	5	39	2.4	46	2.5
	Total	1,630	100.0	1,825	100.0
Tension	1	861	52.9	901	49.4
	2	566	34.7	694	38.1
	3	201	12.3	226	12.4
	4	1	0.1	2	0.1
	Total	1,629	100.0	1,823	100.0
Breathing	1	1509	92.6	1514	92.9
	2	120	7.4	115	7.1
	Total	1,629	100.0	1,629	100.0
Kicking	1	1624	99.7	1818	99.6
	2	5	0.3	7	0.4
	Total	1,629	100.0	1,825	100
Vocalization	1	1,579	96.9	1757	96.3
	2	50	3.1	68	3.7
	Total	1,629	100.0	1,825	100

According to Petherick et al. (2009), flight speed would be more related to an innate component of temperament, while crush scores would be related to a learning component, indicating the importance of animal age in temperament assessment. In the present study, all measurements were taken at calf weaning around eight months of age, and all calves were raised under similar conditions, that is, under the same workforce, pasture areas, and infrastructure.

Regarding electronic evaluation parameters, Schwartzkopf-Genswein et al. (2012) observed positive and significant correlations of 0.24 to 0.39 between them and crush score, with values similar to those of the objective reactivity score. The authors concluded that there was a good agreement between the objective methods tested (equipment) and the crush scores evaluated by a highly trained observer. When evaluating temperament, Parham et al. (2019) studied the impact of the experience and number of observers over inter-observer reliability and measure repeatability, concluding that all methods were highly repeatable and that there was no susceptibility to individual bias in distinguishing behaviors in subjective temperament methods.

The results obtained in the present study for the Canchim breed were similar to those of Maffei et al. (2006) using REATEST to calculate the correlations for objective reactivity score, flight speed, and an adapted temperament score for 610 Nellore yearling animals. The authors reported correlations ranging from -0.34 to -0.18 for objective reactivity score x flight speed, from 0.82 to 0.85 for objective reactivity score x temperament score, and from -0.41 to -0.22 for flight speed x temperament score.

The results obtained for Canchim calves indicated that movement, objective reactivity score, and tension were more promising than flight speed for evaluating temperament (Table 3). According to Grandin & Shivley (2015), the efficiency of exit-speed tests may be low for purebred *B. indicus* because these animals can lie down when they become fearful or freeze as a response to being handled and restrained, which was also observed in some cases in the present study. Animals with high scores for movement and tension showed stressful behavior when on the scale, freezing after the gates were opened, taking longer to pass through the flight-speed sensor. Similarly, Grandin & Shivley (2015) concluded that chute scoring works best when the animal is not tightly restrained.

The correlation analysis also identified a significant correlation between measurements obtained at 10 and 20 s within the same trait (in this case, tension, movement, and breathing), ranging from 0.82 to 0.88 ($p<0.01$).

In the literature, the length of time taken to observe animals during temperament evaluation

Table 3. Spearman's correlation matrix of the temperament variables of Canchim (5/8 Charolais x 3/8 Zebu) calves evaluated using an accelerometer (REAC), a photoelectric sensor (FS), and visual assessment (MOV, TEN, BRE, VOC, and KICK at 10 and 20 s).

Variable[1]	REAC	MOV_10	MOV_20	TEN_10	TEN_20	BRE_10	BRE_20	VOC_10	VOC_20	KICK_10	KICK_20	FS
REAC	1	0.66*	0.67*	0.61*	0.60*	0.30*	0.30*	0.10*	0.05	0.09*	0,07*	0.30*
MOV_10		1	0.82*	0.77*	0.68*	0.32*	0.34*	0.11*	0.11*	0.06*	0.05	0.30*
MOV_20			1	0.69*	0.70*	0.32*	0.36*	0.10*	0.06*	0.06	0.05	0.30*
TEN_10				1	0.88*	0.37*	0.37*	0.12*	0.11*	0.06	0.08	0.35*
TEN_20					1	0.35*	0.36*	0.11*	0.09*	0.05	0.07	0.33*
BRE_10						1	0.86*	0.03	0.03	0.15	0.16	0.25*
BRE_20							1	0.03	0.04	0.16	0.13	0.25*
VOC_10								1	0.71*	0.12*	0.10*	0.09
VOC_20									1	0.11*	0.08*	0.05
KICK_10										1	0.68*	0.01
KICK_20											1	0.03
FS												1

[1]REAC, reactivity score at 20 s (points); MOV_10 and MOV_20, movement scores at 10 and 20 s, respectively; TEN_10 and TEN_20, tension scores at 10 and 20 s, respectively; BRE_10 and BRE_20, breathing scores at 10 and 20 s, respectively; VOC_10 and VOC_20, vocalizing scores at 10 and 20 s, respectively; KICK_10 and KICK_20, kicking scores at 10 and 20 s, respectively; and FS, flight speed from cattle crush ($m\ s^{-1}$). *Significant correlation when $p<0.01$.

varies considerably. When evaluating crush of beef cattle using a score for movement, Kadel et al. (2006) considered a 10 s period. However, when evaluating cattle crush response of beef cattle with restricted head movement, Kilgour et al. (2006) observed each animal for 2 min. In the present study, except for kicking, the correlation between evaluation at 10 and 20 s was positive and high, ranging from 0.68 to 0.88 ($p < 0.01$) (Table 3), indicating that the evaluation of Canchim temperament can be conducted over a shorter period of time, speeding up the process and favoring the management of the animals.

The principal component analysis (PCA) showed that the first three components (PC1, PC2, and PC3, respectively) explained 40.27, 14.33, and 9.4%, i.e., 64%, of the total data variation. These three components presented the highest eigenvalues (above 1.0), encompassing the highest data variance (Table 4).

In order of importance, the variables that contributed the most to the eigenvalues of the principal components were: tension at 10 s, movement at 10 s, movement at 20 s, tension at 20 s, and objective reactivity score for PC1; vocalization at 10 and 20 s for PC2; and vocalization at 10 and 20 s for PC3 (Figure 1 and Table 5).

The PCA results also showed that kicking and vocalization contributed the least to the variation in the analysis (Figure 1 and Table 5). In this line, studying the reactivity of beef cattle arriving at an expo event, Carvalho et al. (2020) observed a low incidence of vocalization, defecation, and urination. Investigating the variability of vocal and behavioral responses to the

Table 4. Principal components (PC), eigenvalues (λi), percentage of variance explained by components (VCP), and accumulated percentage of variance explained.

PC	λi	VCP (%)	Accumulated VCP (%)
PC1	4.833	40.274	40.274
PC2	1.719	14.327	54.601
PC3	1.127	9.395	63.996
PC4	1.014	8.453	72.449
PC5	0.975	8.124	80.573
PC6	0.802	6.681	87.254
PC7	0.480	4.000	91.255
PC8	0.345	2.871	94.126
PC9	0.307	2.561	96.686
PC10	0.215	1.790	98.476
PC11	0.104	0.870	99.347
PC12	0.078	0.653	100.000

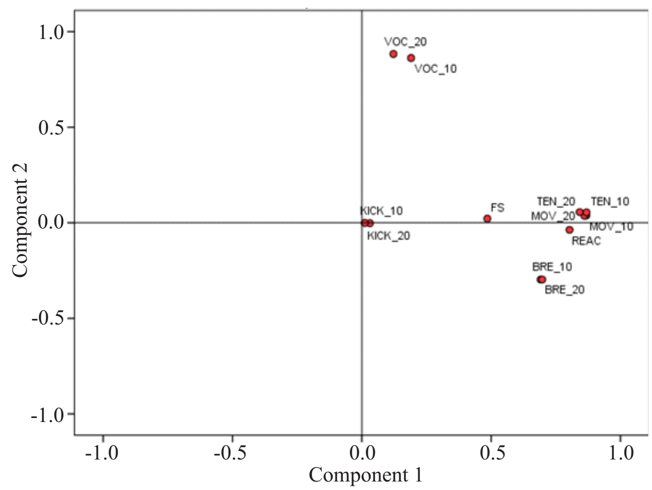

Figure 1. Plot of the principal component analysis of the evaluated temperament variables with the two first components (PC1 and PC2). REAC, reactivity score at 20 s (points); MOV_10 and MOV_20, movement scores at 10 and 20 s, respectively; TEN_10 and TEN_20, tension scores at 10 and 20 s, respectively; BRE_10 and BRE_20, breathing scores at 10 and 20 s, respectively; VOC_10 and VOC_20, vocalizing scores at 10 and 20 s, respectively; KICK_10 and KICK_20, kicking scores at 10 and 20 s, respectively; and FS, flight speed from cattle crush (m s^{-1}).

Table 5. Loadings of the temperament variables for each principal component (PC1, PC2, PC3, and PC4), evaluated using an accelerometer (REAC), a photoelectric sensor (FS), and visual assessment (MOV, TEN, BRE, VOC, and KICK at 10 and 20 s).

Variable[1]	PC1	PC2	PC3	PC4
REAC	0.802	-0.040	0.181	-0.070
MOV_10	0.869	0.040	0.168	-0.063
MOV_20	0.866	0.039	0.238	-0.072
TEN_10	0.866	0.050	0.250	0.056
TEN_20	0.841	0.053	0.250	0.055
BRE_10	0.688	-0.288	-0.579	0.025
BRE_20	0.695	-0.288	-0.550	0.024
VOC_10	0.184	0.867	-0.230	0.008
VOC_20	0.124	0.890	-0.186	0.003
KICK_10	0.032	-0.003	0.308	-0.630
KICK_20	0.012	-0.002	0.292	0.764
FS	0.485	0.010	0.060	0.107

[1]REAC, reactivity score at 20 s (points); MOV_10 and MOV_20, movement scores at 10 and 20 s, respectively; TEN_10 and TEN_20, tension scores at 10 and 20 s, respectively; BRE_10 and BRE_20, breathing scores at 10 and 20 s, respectively; VOC_10 and VOC_20, vocalizing scores at 10 and 20 s, respectively; KICK_10 and KICK_20, kicking scores at 10 and 20 s, respectively; and FS, flight speed from cattle crush (m s^{-1}).

visual isolation of full-siblings of beef cattle, Watts et al. (2001) concluded that there is no clear relationship between individual temperament, assessed as body movement during isolation and vocal response. Other studies have found that cattle vocalize in response to a painful event, in contact with sharp edges, or due to excessive pressure from a restraint device (Grandin, 2001; Grandin & Shivley, 2015), which did not occur in the present study.

Conclusions

1. When evaluating the temperament expression of Canchim calves, the traits movement and tension, evaluated visually, and objective reactivity score, by an electronic device, show similar results.
2. Movement, tension, and objective reactivity score can be used to assess temperament in commercial herds.
3. Temperament can be evaluated 10 s after cattle is restrained.

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