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An Approach to Rumen pH and Temperature Dynamics during the Bullfight and its Settings

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Abstract

The objective of this work is to know the dynamics in the bull ruminal environment (pH and temperature) during the traditional Spanish bullfighting (maximum productive performance) and its previous and later moments. For this, rumen environment of three Lidia bulls has been monitored during the bullfighting and its settings. The bullfighting affects rumen environment by lowering pH and rising temperature. Rumen temperature increases as time progresses as a consequence of physical activity, starting to decrease just after bullfighting. On the contrary, rumen pH does not seem to be correlated to temperature or time.

Keywords: Lidia bull; Performance; Monitoring

Introduction

The bullfight ("lidia") can be defined as the intelligent use of all the spontaneous reactions of the bull, combined with those caused by the bullfighter, that is, everything that is done or avoided to do to a bull, in order to improve its behaviour [1]. During the play, the bullfighter has to deceive his adversary (the bull) in a loyal and ethical way. Each bull has particular features and idiosyncrasy, so the bullfighter must adjust the action to the unique conditions of his opponent, different from all others, because it is deadly and fights only once. The bull has an unique character, which must be discovered, and its unpredictable behaviour, however, must be anticipated by the bullfighter [2].

From the physiological point of view, the fight is an anaerobic exercise due to its metabolism. However, given the high intensity of exercise, its duration and characteristics, it can be considered an aerobic exercise, where periods of intense activity and rest of variable duration are combined [3]. The fight has, therefore, a first part of intense exercise with anaerobic activity and a second part of activity more continuous and less intense with breaks, which could be considered as aerobic. In such situation of intense exercise, muscle fibres of fast contraction and low oxidative capacity (type II) are mostly in operation, energy for the effort being obtained through anaerobic glycolysis, which results in lactic acid. During the fight it is possible that the bull suffers the negative effect of lactic acid giving rise to muscle fatigue, since this acid quickly becomes lactate in the blood.

Although they are often used invariably, lactic acid and lactate are not the same: lactate is formed when lactic acid loses a hydrogen atom. In this way, the hydrogen atom lost by lactic acid stays in the blood, which can lead to a drop in blood pH [4].

Likewise, according to Bartolomé, it is possible that the acidosis derived from exercise is accompanied by concomitant processes of ruminal acidosis, which would result in the appearance of falls during the fight in the bullring [5]. This can be aggravated due to lesions (mainly liver lesions) derived from ruminal acidosis.

The studies carried out so far in relation to the evaluation of ruminal pH refer to data taken from the animals after the fight [4,6-9], all of them made directly on the ruminal content, once the animal has been sacrificed. In this sense, in order to clarify the determining role of bullfight on the final pH observed after the fight, the objective of the present work is to know the dynamics in the bull ruminal environment (pH and temperature) during the bullfight and its previous and later moments.

Materials and Methods

Animals and location

Five 4-year-old Lidia Bulls were used. Animals were handled according to the usual management in their ranch, Tejeda y Segoyuela (Salamanca, Spain; 40° 37′ 56″ N 6° 01′ 21″ O; 927 m above sea level, Köppen- Geiger's climate classification: Csb), and were fed on a total mixed ration (TMR).

pH and temperature boluses

The pH and the rumen temperature were measured, continuously, using Internal wireless smaXtec® boluses (SmaXtec animal care salts GmbH, GRAZ, Austria), developed and evaluated by Gasteiner et al. [10]. This bolus (132 × 35 mm size) collects the values of pH (0-14 ± 0.2 units) and temperature (25-50 ± 0.2°C) every 10 minutes during the entire measurement period: from 30 minutes before the bullfight to 80 minutes after its end.

Each bolus was adjusted using pH 4 and 7 standards before being used. Once calibrated, the bolus was orally introduced (with an applicator) to be hosted in the reticulum, where it remained until the animal was sacrificed, at which time it was recovered. Data were

recorded by using a mobile reader and displayed using a particular software (SmaXtec).

Bullfight

The bullfight was carried out in the ring located at the ranch. The ordinary bullfight consists of three parts (called thirds–"tercios"): rods and distractions ("varas y quites"), sticks ("banderillas") and cape and death ("muleta y muerte") divided by Alcántara) [1]. Two modifications were introduced in the present experiment: firstly, no sticks were used. And secondly, animals were not killed at the end of the bullfight, they were showered (to clean and cool down) and transported to a slaughterhouse where they were slaughtered following normalized procedures.

Statistical analysis

The data of temperature and pH obtained were averaged for each of the phases: before the fight (30 minutes, 'previous'),'bullfight', and two sections of 40 minutes after the fight ('later 1' and 'later 2').

An analysis of variance of the data was performed to compare the average pH and temperature values during each of the phases, also performing a correlation analysis of the pH and temperature data in each of the phases.

The data were processed using the general linear model and the means were compared ($p<0.05$) using the LSM test of the statistical package SSPS (V16.0, SPSS, INC., Chicago, Illinois, USA).

Results and Discussion

The average values of pH and temperature in the moments prior to the fight, during this and in subsequent moments are listed in Table 1.

	Previous	Bull fight	Later 1	Later 2	r.s.d.	P value
pH	6.25^b	6.21^b	5.99^a	5.90^a	0.115	<0.001
Temperature	40.4^a	41.2^b	41.6^b	40.4^a	0.58	<0.001

Table 1: Average values of pH and temperature in the moment prior to the bullfight, during it and in the 40 (later 1) and 80 (later 2) minutes after it. r.s.d.=residual standard deviation. a, b Different superscripts in the same row indicate significant differences ($P<0.05$).

In spite of the individual variations, in a general way, there is a decrease in rumen pH values during the bullfight, which is maintained for a time after the end of the fight (Figure 1). This may be due to the compensation mechanisms that are activated throughout the bullfight to respond to the dehydration and the consequent haemoconcentration [7].

During the bullfight, haemoconcentration and dehydration occur due to fluid loss, which could even further increase the concentration of lactate in the blood [4]. The absorption of liquids at the ruminal level is greatly increased to counteract this dehydration.

The rumen is the largest reservoir of water that ruminants have; it is estimated that in cases of severe dehydration, rumen can contribute to the 50% of the body water lost [11,12]. That is to say, much of the water lost (by deprivation of drink, extreme heat, panting, loss of blood) is recovered to the bloodstream from the rumen to maintain blood volume. Conversely, in cases of dehydration there is a considerable reduction in the secretion of saliva, which, moreover, becomes isotonic with the blood [11,12]. Due to the decrease in the saliva flow (and therefore bicarbonate) to the rumen, there is a loss of buffer capacity at this level. This circumstance is particularly relevant in animals fed with rations based on concentrates, because the fermentation processes in the rumen continue, albeit at lower rates, after the deprivation of food and water. Thus, after the withdrawal of food, volatile fatty acids (VFAs) continue to be produced [13], and their concentration increases, this being exacerbated by the decrease in the volume of water in the rumen. In addition, the capacity of absorbing and metabolizing VFAs through the rumen wall in this type of animals is diminished due to the keratinization of the epithelium (hyperkeratosis and parakeratosis) [14-16]. These circumstances altogether favour the accumulation of VFA (particularly propionic acid) in the rumen, thereby contributing to decrease rumen pH. As a result, changes in the ruminal environment may contribute to worsening of the clinical symptoms of acidosis: tiredness, difficult breathing, etc., all of which would result in a loss of quality of the show, lack of strength of the bulls, falls [7]. In this sense, Bartolomé showed that 71% of bullfighted bulls were affected by this pathology [5].

The physical exercise performed by the animal during the fight represents an effort that implies an increase in the production of heat by the organism [17]. Some authors indicate that the rumen can be an indicator of body temperature relatively independent of external factors [18]. As can be seen in Figures 2 and 3, there is a concomitant increase in the temperature at ruminal level associated with the activity during the bullfight. The heat produced by exercise is sufficient to raise body temperature 1°C every 5-8 minutes of activity [17]. However, in the present work, ruminal temperature rises by an average of 1°C, with the average duration of the fight being 29 minutes. This difference in the increase in body temperature could be due to the fact that blood activity and irrigation at the ruminal level are diminished to favour the contribution to other organs that require more activity during the fight.

In addition, as a consequence of the movement of fluids, the fermentative activity of the rumen could be compromised, which would contribute to alleviate the raise in rumen temperature [19].

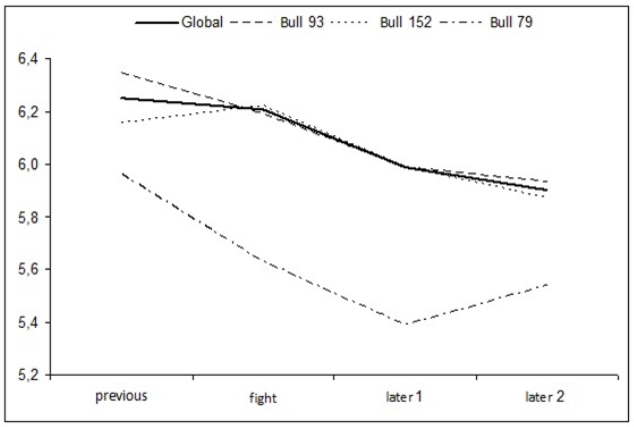

Figure 1: Evolution of ruminal pH in the three bulls tested in the moment before the bullfight, during it and in the 40 (post 1) and 80 (post 2) minutes after it.

The maximum temperature is reached immediately after the end of the fight, followed by a rapid descent.

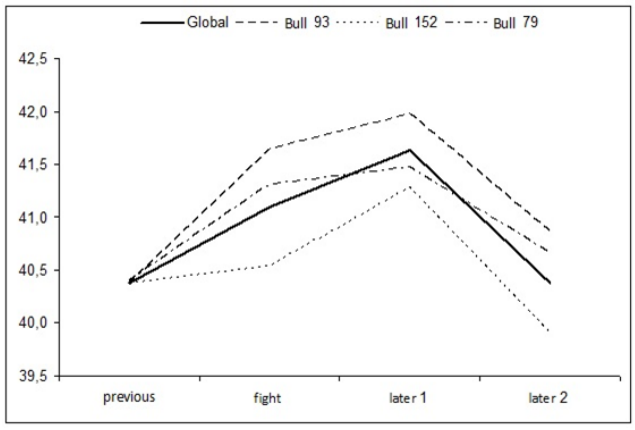

Figure 2: Evolution of the ruminal temperature (°C) in the three bulls tested in the moment before the bullfight, during it and in the 40 (later 1) and 80 (later 2) minutes after it.

Figure 3 shows the existence of a significant inverse relationship between pH and ruminal temperature of the bulls at the time of the fight (the temperature increased as the pH decreased). However, the level of statistical significance varied with each animal. Given the variation among individuals, when the data of all the animals were taken into account in a joint manner, the observed correlation coefficient did not reach the required statistical significance level. A significant correlation between temperature and time, both in the previous moments and during the fight, has been observed (Table 2).

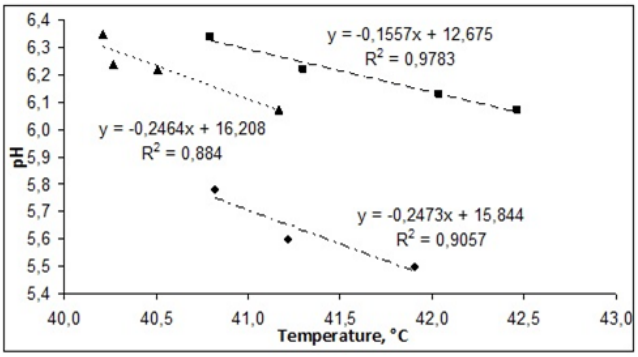

Figure 3: Relationship between rumen pH and temperature during the bullfight for each of the bulls (=bull 1, =bull 2, =bull 3). *=P<0.05; t=P<0.10; n.s=P>0.10.

This decrease could be explained by two reasons: on the one hand, the cessation of physical activity and, on the other hand, especially, the fact that the animals were showered to clean and cool down after the bullfight.

The increase in the ruminal temperature (and, therefore, body temperature) that occurs during the fight starts up the mechanisms of thermoregulation whose mission is to maintain the body temperature within the physiological range, for the organism to comply with all its functions.

In this way, positive correlations were observed before and during the bullfight, which would indicate an increase in temperature as time passes from before the fight until it ends, associated, undoubtedly, with the increase of physical activity and its maintenance throughout the bullfight. Subsequently, a significant negative correlation between time and temperature is observed in the moments after the bullfight. The latter would indicate a drop in temperature once it ends, which could be explained by the cessation of physical activity and the shower. A significant relationship between time and rumen pH has not been observed instead.

Correlations before the bullfight		
	pH	Temperature
Time	-0.349	0.885**
pH		-0.201
Correlations at the time of the bullfight		
	pH	Temperature
Time	-0.128	0.633*
pH		-0.416
Correlations after the bullfight (40 min)		
	pH	Temperature
Time	0.147	-0.653*
pH		0.289
Correlations after the bullfight (80 min)		
	pH	Temperature
Time	-0.309	-0.547*
pH		-0.091

Table 2: Correlation coefficients between rumen pH and temperature (of all animals) at different times. Significant correlation at P<0.05. **Significant correlation to P<0.01.

Conclusion

The results observed in this work show that the bullfight influences ruminal environment by reducing pH and increasing temperature values. Ruminal temperature increases as time progresses in direct response to physical activity, decreasing after activity cessation and with the shower.

The low values of ruminal pH found at the end of the bullfight seem to be related, not only to phenomena of ruminal acidosis (derived from feeding with acidotic rations), but, clearly, to the negative effect that the bullfight has proven to have about this parameter.

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