PRODUCTIVE, PHYSIOLOGICAL AND SOCIAL BEHAVIOUR CHARACTERIZATION, OF THREE CONTRASTING PRODUCTION SYSTEMS OF HOLSTEIN STEERS.

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Abstract - Beef production with Holstein male calves is becoming more intensive in Uruguay. The new confined systems could improve productivity but also could compromise animal welfare. The aim of this study was to compare animal welfare and productivity of castrated young males reared in three different systems. The traditional pastoral system was compared with, a confined fattening system and an alternative one with confinement and 6 diary hours access to pastures. No differences were found in weight gain or physiologic indicators of stress, but the agonistic behaviour increased in the confined fattening system.

INTRODUCTION

Dairy production is a very important economic activity in the south of Uruguay. The increasing cattle stock makes Holstein male calves economically available for beef production. In dairy production systems, grazing and grain supplementation are well known by producers, and consequently, some alternatives of calves fattening, which combine characteristics of both confined and grazing systems are becoming more common. The development of alternative housing systems for beef production becomes more and more important [1].The intensive production systems modify animal conditions, by reducing their space allowance influencing social behaviour [6]. Subsequently, competition for resources such as food or attractive resting places may cause aggression and social stress [11]. Therefore, the objective of this experiment was to compare animal welfare and productivity of castrated young males reared in three different systems. The traditional pastoral system, a confined fattening system based on grain and hay feeding and an alternative one with confinement and 6 diary hours access to pastures.

MATERIALS AND METHODS

The experiment was carried out at Las Brujas Experimental Centre of the National Agricultural Research Institute (INIA) of Uruguay (34º40`S lat, 56º20´W, 36m alt). The experimental period lasted 133 days, from August 4 to December 16 of 2008.

ANIMALS AND HOUSING

Experimental design was established according to Manninen et al., (2007) [7]. Forty eight Holstein castrated males (mean live weight 93±20.3 kg), were randomly divided in three groups (16 calves each) corresponding to three treatments:

(T1) confined into a 210 square meters yard,
(T2) confined into a 210 square meters yard with six hours of access to grassland,
(T3) permanent placed at grassland.

The experimental yards (treatments T1 and T2) were outdoor, 21x10m and , built with electric fencing. The grassland parcels were also built with electric fencing, and the surface was calculated depending on the forage offered to reach 8% of average live weight *per* animal. Average surface was about 2000 square meters.

PRODUCTIVE MEASURES

Animals were individually weighed every two weeks. Average daily gain was calculated for each period. Provided feed *per* group was weighed every day and then, food intake of each group was weekly measured for hay and grain supplement. Pasture intake was calculated as the difference between offering (availability at the moment of opening a new grazing parcel) and remaining (availability at the moment of taking out the animals of the parcel) with an standard method [8].

SOCIAL BEHAVIOUR

Calves interactions were directly observed during twelve hours a day (from 7:00 to 19:00), three days per week in four weeks distributed throughout the experiment (weeks 7, 10, 13 and 16). Six people were trained to perform the behavioural observations, and then, there was one observer for each treatment, in three hours turns. Observers were randomly assigned to each treatment and timetable every day. An interaction was considered when physical contact between two animals was produced. Activities were registered continuously and they are described in Table 1.

Table 1. Observed interaction between calves and its respective descriptions.

Behaviour	Description
Mounting (M)	Calf clasping or trying to clasp other calves back with both legs
Displacing (D)	One calf displacing another, with shoulder, side, flank or rump from its standing or lying place.
Pushing with chest (P)	One calf pushing with the chest to another calf from its standing place
Head Knocking (H)	One calf knocking another with the head in any part of its body
Licking a group mate(L)	Calf licking another at any part of its body
Smelling a group mate (S)	Calf smelling another with contact with its skin
Scratching with other (SO)	Calf scratching with the body of another calf

Complementary, two new variables were created: positive interactions (PI) by integrating all non-agonistic social behaviour (L, S and SO) and negative interaction (NI) by integrating all agonistic social behaviour (M, D, P, and H).

CORTISOL AND BIOCHEMICAL PROFILE

Nearby the end of the experiment (day 120), eight animals were randomly chosen from each group and blood samples were taken from jugular vein puncture. Cortisol concentrations were determined by a direct solid-phase radioimmunoassay (RIA). In addition, twelve biochemical parameters were determined by IDEXX VetTest® Chemistry Analizer: Alanine Trasnpherase (ALT), Alkaline Phosphatase (ALKP), Gamma Glutamine Transferase (GGT), Albumine (ALB), Glucose (GLU), Total Protein (TP), Urea (BUN), Total Bilirubine (TBIL), Creatinine Kinase (CK), Calcium (Ca), Phosphates (PHOS), Globuline (GLOB).

STATISTICAL ANALYSIS

Data were analyzed by the Statistical Analysis System package (SAS, 2008). Live weight was analyzed using the Mixed Procedure (PROC MIXED) with repeated measures, with initial weight as a covariate. Tukey-Kramer adjustments were used for post-hoc comparisons. Data from cortisol and the biochemical profile were transformed throw LN(1+value) in order to normalize residual errors and variance analyzed by a General Linear Model Procedure (PROC GLM). Interactions between animals were expressed as a count and logarithmic transformation (Ln) and analyzed using the Mixed Procedure (PROC MIXED).

RESULTS

PRODUCTIVE MEASURES

Figure 1 shows average live weight evolution for each treatment. Live weight (LW) did not differ between Treatments for the period studied (P=0.6842) and its evolution was similar for the three treatments (Figure1). Average daily gain (ADG) was 0.756±0.829, 0.757±0.676 and 0.730±0.762 kg/day for T1, T2 and T3 respectively (p=0.1254).

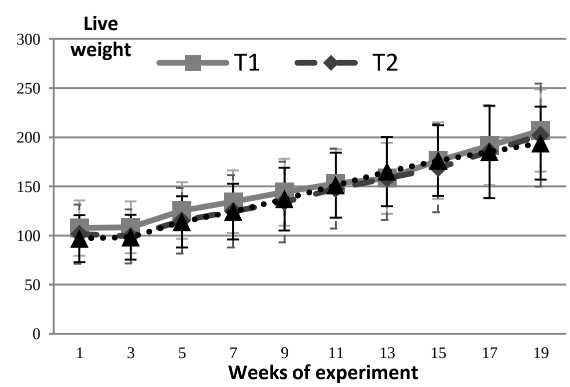

Figure 1 – Live weight evolution (kg) from the end of adaptation period until the end of the experiment

Production system including pasture did not mean benefits or detriments in live weight as compared to more intensive systems. Nevertheless, these ADG are lower than those reported by other authors [2, 10]. As regards to total dry matter (DM) and total nitrogen (N) intake from the different feeding sources, results were 15323, 20910 and 16205 kg of DM and 354 502 and 452 kg of N for T1, T2 and T3 respectively. Feed conversion rates for each group were 9.5, 13.0 and 10.0 for T1, T2 and T3 respectively. Analyzing the components of this DM intake for T1 and T2, very similar pasture intakes being 12302 and 14494 kg respectively, although T2 had only 6 hours of access to the pasture. This means that animals with restricted time for grazing intensified it in the access period and reached similar intakes. respectively. However, N content of total dry matter intake (DMI) was not different, being 2.3, 2.4 and 2.5 % for T1, T2 and T3.

SOCIAL BEHAVIOUR

Daily average number of interactions for the three treatments is presented in Table 2. In general, positive interactions did not differ between treatments (P=0.1496) whereas negative interactions (aggressions) resulted higher in T1 (P<0.0001). The same situation was observed for all separated aggressions, except for M which did not differ significantly between treatments. H was the most frequent aggression in T1. In T2 and T3 it showed no differences to M frequency. Regarding PI, L was the most frequent activity within all treatments. The increase of the agonistic behaviour as a consequence of a reduction in space allowance was previously reported by several authors [4, 6, 9], but in the present work the space availability for animals was sensible higher.

Table 2 - Average daily interactions of calves within each treatment (means ± S.D.)

	T1	T2	T3	P value
H	5.8±6.3 ^{b}	2.7±2.5 ^{a}	1.9±2.3 ^{a}	<.0001
P	3.2±5.6 ^{b}	1.1±1.8 ^{a}		0.0002
D	2.2±4.0 ^{b}	0.9±1.5 ^{a}	0.8±1.8 ^{a}	0.0038
M	2.2±2.1	2.7±3.6	2.5±2.6	0.9981
L	8.7±7.2	7.2±8.4	6.7±6.9	0.1936
SO	1.3±2.1	1.4±2.2	0.8±1.7	0.3138
S	3.3±5.1	2.0±3.4	2.0±4.0	0.0937
PI	13.3±12.2	10.5±11.4	9.5±10.4	0.1496
NI	13.4±13.6^{b}	7.4±5.4 ^{a}	5.9±4.6 ^{a}	0.0001

$^{a\ b}$ Means with no common superscript differ significantly (P<0.05)

On the other hand, related to the interaction between the moment of the day and treatments, no significant differences were found for any of the observed activity.

CORTISOL AND BIOCHEMICAL PROFILE

Average cortisol concentration did not show differences between treatments (P=0.7189), and means for T1, T2 and T3 were 2.15±1.69, 2.54±1.54 and 2.05±0.81 ug/dL, respectively. In the current study, the surface used in the most restricted treatment (T1) was of 13.1 m^2 per animal, which is a higher space allowance compared to the previously cited works and mostly considering the references established by the European Union –(1,5 to 1.8 m^2 *per* animal) [3]. This high space allowance in the confined system probably explained those cortisol results, suggesting that even in the confined system, animals had enough space and consequently they were not subjected to a high stress situation. Biochemical profile of blood serum is presented in Table 3. In most of them, no differences were found between treatments and medias values were inside the reference ranges except for CK and GLU, which levels exceeded them in the three treatments.

Animals in T3 reached the highest concentration of BUN. This happen when crude protein in diet increases, maintaining energy levels [5]. That situation occur in T3 due to a high consume of high degradable protein with pasture, but without grain for increasing energy.

CONCLUSIONS

In general, the three studied treatments resulted to be very similar in productive terms, although several aspects must be deeply studied. There are no evidences of increasing stress or health problems in any production system. Confined animals increased agonistic behaviour, which probably reflect some welfare problems.

Table 3 – Biochemical profile. Serum concentration of Alanine Trasnpherase (ALT), Alkaline Phosphatase (ALKP), Gamma Glutamine Transferase (GGT), Albumine (ALB), Glucose (GLU), Total Protein (TP), Urea (BUN), Total Bilirubine (TBIL), Creatinine Kinase (CK), Calcium (Ca), Phosphates (PHOS), Globuline (GLOB). Mean ± S.E.

	Units	Reference values	T1	T2	T3	P-value
ALT	U/L	4-11	93.44 ± 6.31	98.14 ± 7.15	89.75 ± 6.69	P=0.6969
ALKP	U/L	10 – 149	115.60 ± 9.92 **a**	102.75 ± 11.10 **a**	67.88 ± 11.10 **b**	P=0.0125
GGT	U/L	0 – 80	15.11 ± 2.86	19.22 ± 2.86	13.43 ± 3.24	P=0.3859
ALB	g/dL	2.5 – 3.6	1.17 ± 0.18	0.89 ± 0.20	0.78 ± 0.23	P=03792
GLU	mg/dL	46.0 – 93.2	127.20 ± 12.79	157.88 ± 14.30	144.38 ± 14.30	P=0.2919
TP	g/dL	5.80 – 8.00	8.01 ± 0.73	7.86 ± 0.81	8.09 ± 0.81	P=0.9802
BUN	mg/dL	7.0 – 17.2	5.60 ± 0.66 **b**	6.38 ± 0.74 **b**	11.83 ± 0.86 **a**	P<0.0001
TBIL	mg/dL	0 – 0.73	0.32 ± 0.02	0.36 ± 0.02	0.37 ± 0.02	P=0.1352
CK	U/L	0 – 110	239.00 ± 116.69	355.67 ± 116.69	321.00 ± 132.32	P=0.7723
Ca	mg/dL	7.8 -10.46	11.17 ± 0.64	11.90 ± 1.21	10.90 ± 0.70	P=0.7765
PHOS	mg/dL	4.29 – 7.89	6.96 ± 0.41	6.74 ± 0.41	6.60 ± 0.50	P=0.8511
GLOB	g/dL	2.70 – 3.80	6.78 ± 0.54	6.74 ± 0.69	6.30 ± 0.69	P=0.8499

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