71st ICoMST
GIRONA - CATALONIA - SPAIN
3rd-8th August - 2025

EFFECT OF COW CALF CONTACT MANAGEMENT SYSTEM ON GROWTH, BEHAVIOUR, METABOLIC RESPONSES AND MEAT QUALITY

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I. INTRODUCTION

Surplus male and non-replacement female calves from dairy herds pose a growing ethical and economic concern due to their limited value in milk production systems and the common practice of early euthanasia or low-value slaughter in some countries [1,2]. In Sweden, about 60% of beef originates from culled dairy cows or their offspring, highlighting the potential role of these calves in sustainable beef production [3]. However, traditional rearing systems involving early separation from the dam and individual housing are increasingly criticized for compromising calf welfare and natural behaviour [4,5]. Cow-calf contact (CCC) systems, which allow extended maternal bonding, are gaining attention as a welfare-friendly alternative that may also support physiological development and meat quality [6]. The aim of this study was to evaluate the effects of a CCC rearing system compared to conventional early separation on growth, physical activity, metabolic traits, and technological meat quality in dairy calves.

II. MATERIALS AND METHODS

The study was conducted at The Swedish Livestock Research Centre, Lövsta (SLU), using 40 dairy cows (Swedish Red and Swedish Holstein). After exclusions for mastitis, trauma, and culling, 33 cows remained. A total of 38 calves (19 per group) were followed from birth to 6–7 months of age. Calves were randomly assigned to either a control group (C; early separation from dam) or a cow-calf contact group (CCC; dam-calf rearing). CCC calves remained with their dams in a loose-housing barn, while control calves were separated at birth and group-housed after initial individual housing. Growth was assessed through birth and final body weight. Physical activity was evaluated via direct behavioural observations. At slaughter, muscle samples were collected from 13 bull calves (7 C, 6 CCC) to assess metabolic responses (citrate synthase activity, and concentrations of glucose and lactate) and the technological meat quality traits ultimate pH, water losses, colour (*L*, a*, b**), and Warner-Bratzler shear force (WBSF). Statistical analysis was performed using Proc. Mixed using SAS 9.4 (SAS Institute, Inc., 2004) with significance set at $p \leq 0.05$.

III. RESULTS AND DISCUSSION

CCC calves had significantly higher final body weight than controls (182 vs. 153 kg; $p = 0.048$), while birth weights were similar (Table 2). This growth advantage likely stems from greater milk access and reduced stress, consistent with previous CCC studies [4].

Calves in the CCC system showed significantly higher physical activity than controls, with increased step counts across walk, trot, and gallop ($p < 0.001$). Control calves performed more “edge passes” ($p = 0.011$, Figure. 1), indicating more constrained, enclosure-limited movement. These findings suggest that CCC supports more natural behaviour, aligning with studies on improved behavioural development through maternal contact [6,7].

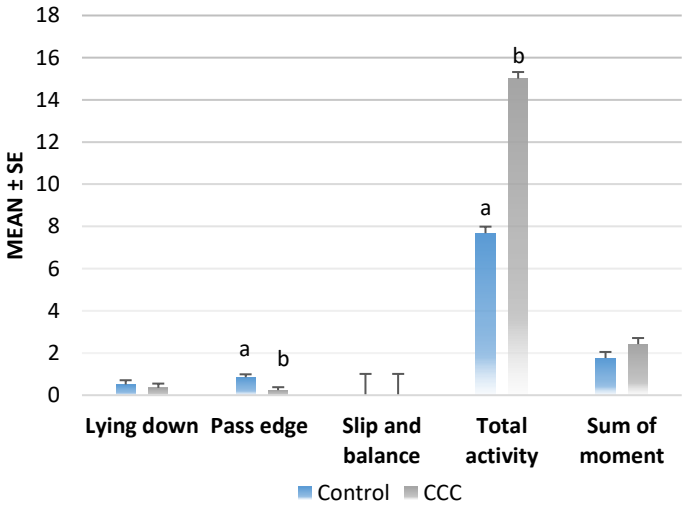


Figure 1: Effect of rearing system on physical activity behaviors in dairy calves.

Higher citrate synthase activity in CCC calves ($p = 0.007$) suggests improved mitochondrial function, potentially linked to greater locomotion. Lactate and glucose levels did not differ, indicating comparable energy metabolism across groups (Table 1).

Table 1: Metabolic and enzymatic traits in muscle tissue from calves across rearing systems.

Variable	Control*	CCC*	p-value
Lactate (mmol/g)	11.3 ± 0.29	10.8 ± 0.29	0.127
Glucose (mmol/g)	1.08 ± 0.08	1.22 ± 0.08	0.106
Mitochondrial Citrate synthase activity (nmole/min/µL)	0.010 ± 0.002	0.015 ± 0.002	**0.007**

*) Least squares means and standard errors. Significant differences are shown by p-values in bold.

Meat from CCC calves had a higher ultimate pH (5.57 vs. 5.46; p = 0.016), possibly due to reduced pre-slaughter stress. However, CCC meat showed lower redness and yellowness (p = 0.002, 0.003), contrary to expectations of enhanced colour with higher oxidative metabolism, potentially due to delayed blooming or surface oxidation. No differences were observed in tenderness, water losses, or lightness (Table 2).

Table 2: Body traits and technological meat quality traits of calves across rearing systems.

Variable	Control*	CCC*	p-value
Birth weight (kg)	38.3 ± 1.68	40.4 ± 2.38	0.184
Final body weight (kg)	153 ± 7.6	182 ± 10.0	**0.048**
Ultimate pH	5.46 ± 0.03	5.57 ± 0.03	**0.016**
Meat colour: Lightness, (*L**)	30.0 ± 0.83	32.1 ± 0.83	0.115
Meat colour: Redness (a*)	12.3 ± 0.80	7.67 ± 0.80	**0.002**
Meat colour: Yellowness (b*)	17.1 ± 0.67	13.6 ± 0.67	**0.003**
WBSF-Peak force (g)	4360 ± 336	4820 ± 336	0.358
Thawing loss (%)	3.08 ± 0.47	2.97 ± 0.47	0.869
Cooking loss (%)	22.3 ± 0.91	22.6 ± 0.91	0.783
Total fluid loss (%)	25.3 ± 1.28	25.6 ± 1.28	0.894

*) Least squares means and standard errors. Significant differences are shown by p-values in bold.

IV. CONCLUSION

Cow-calf contact (CCC) rearing improved growth performance, physical activity, and mitochondrial function in dairy calves, without compromising meat tenderness or water-holding capacity. Although meat colour differed, with lower redness and yellowness in CCC calves, the overall meat quality remained comparable. These findings highlight CCC as a welfare-enhancing system with potential benefits for calf development and sustainable dairy-beef production.

V. ACKNOWLEDGEMENTS

We gratefully acknowledge the Beijer Foundation (Uppsala, Sweden), the Swedish Research Council Formas (Stockholm, Sweden; grant number 2018-01500), and the Seydlitz MP Bolagen Foundation (Vetlanda, Sweden) for funding this research. We also thank the staff at the Swedish Livestock Research Centre (Uppsala, Sweden) for their support with conducting the trial.

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