Slowly Fermentable Grains May Reduce Metabolic Heat and Ameliorate Heat Stress in Grain-Fed Sheep

P.A. Gonzalez-Rivas, K. DiGiacomo, V. M .Russo*, B.J. Leury, J.J. Cottrell, and F.R. Dunshea

Faculty of Veterinary and Agricultural Sciences, The University of Melbourne, Parkville, Victoria, Australia.
***Department of Economic Development, Jobs, Transport and Resources, Ellinbank, Victoria, Australia.**

INTRODUCTION

- Ruminants can be more susceptible to **Heat stress** (Coppock, 1985; Goetsch and Johnson, 1999; Roy and Collier, 2012).

- Rapidly fermentable grains (**wheat**); digestive disorders, laminitis and higher metabolic heat production (Nocek, 1997; Oetzel and Smith, 2000; Stone, 2004, Grant and Albright, 1995; Brosh et al., 1998; Mader et al., 1999).

- Slowly fermentable grains (**corn**); better utilization of ME and reduction of the heat from fermentation (Ørskov, 1986; Owens et al., 1986).

Objectives

- To characterise the *in vitro* gas production kinetic parameters of wheat and corn grains.
- To compare physiological parameters of sheep fed either *slowly* or *rapidly* fermentable grain-based diets under heat stress conditions.

Hypotheses

- Wheat has a faster rate of *in vitro* fermentation than corn.
- Feeding *slowly fermentable grains* can reduce the impact of heat stress in grain-fed sheep.

MATERIAL AND METHODS

In Vitro Experiment

- 28 replicates of 1g of 1mm-ground wheat ASW 10% (70% starch) and corn (74% starch).
- Buffered rumen fluid (Kansas-State buffer pH 6.8) ratio 1:3
- Gas recording modules ANKOM^{RF} Wireless system every 5 minutes
- Incubated for 24 h at 39ºC

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MATERIAL AND METHODS

In Vivo experiment

Experimental Design

Randomized Control Trial

Animals

- 22 Merino X Poll Dorset crossbred wether lambs.
- 11-12 mo
- 41.2±2.4 Kg BW
- Fleece cover 3 cm

MATERIAL AND METHODS

Diets

- **Control - rapidly fermentable diet** "Wheat Diet"

  50% crushed wheat grain + 50% of oaten/lucerne chaff

- **Intervention - slowly fermentable diet** "Corn Diet"

  50% crushed corn grain + 50% of oaten/lucerne chaff

  Both: 4% DM Balanced Supplement

  12.7 % CP, 11.9 MJ ME/Kg DM,

  23.8% NDF and 37.9% starch

  Fed three times a day (0900, 1300,1700h)

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MATERIAL AND METHODS

Accl. (15 d)

- **Acclimation feeding** (1.5 x Maintenance requirements)

Period 1 (P1,7d)

- **Thermoneutral** (18 to 21^{0}C and 40-50% RH, 24 h)
- **Restrictive feeding** (1.3 x Maintenance requirements)

Period 2 (P2, 7d)

- **Heat stress** (38^{0}C/ 30% RH; 0900 to 1700 h, 28^{0}C/50% RH;1700 to 0900 h)
- **Restrictive feeding** (1.3 x Maintenance requirements)

Period 3 (P3,7d)

- **Heat stress** (38^{0}C/ 30% RH; 0900 to 1700 h, 28^{0}C/ 50% RH;1700 to 0900 h)
- **Acclimation feeding** (1.5 x Maintenance requirements)

PHYSIOLOGICAL MEASUREMENTS

- **Respiration rate (RR)**
- **Rectal temperature (RT)**
- **Left and right flank skin temperature (LST and RST)**
- 0900, 1300, 1700 and 2100h during the experiment.
- **Feed /water intake**

STATISTICAL ANALYSIS

In vitro gas production

- Gas production curve was fitted to the *Gompertz* model. REML using the statistical package GenStat (GenStat release 14; VSN International Ltd., Hemel Hempstead, UK)

$$Y = A + C \exp(-\exp(-B(X-M)))$$

Where:

- B = Rate of gas production (mL h^{-1})
- M = Time at which the maximum rate of gas production is reached (h)
- C = Maximum gas produced (Max $_{gas}$ mL/g DM)
- A = Y-intercept

STATISTICAL ANALYSIS

In vivo experiment

- Restricted Maximum Likelihood (REML) analysis procedure for GenStat

- True differences between left and right flank skin temperature were estimated by conducting a t-Test.

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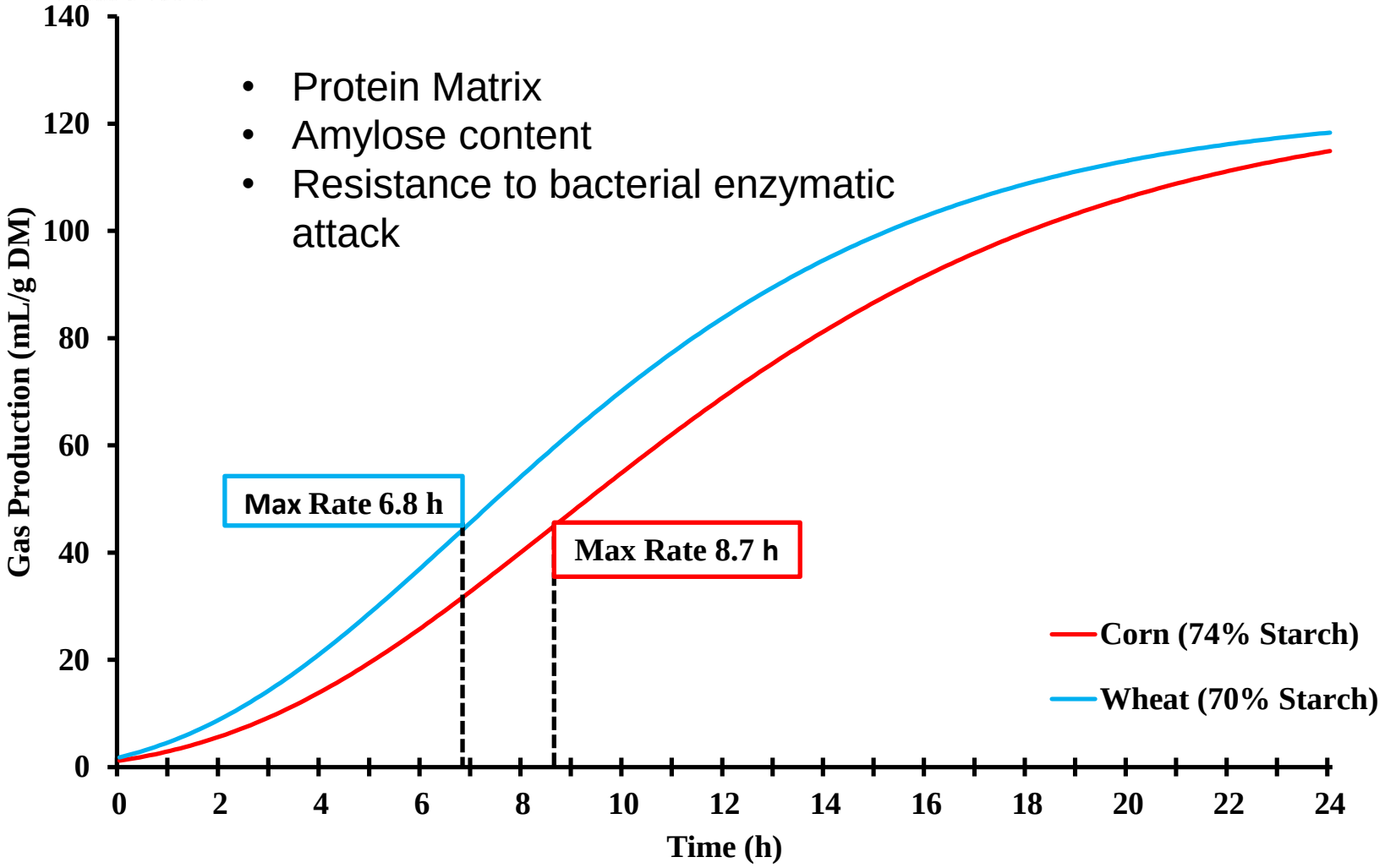
Corn had slower rate of gas production (ml gas h^{-1}) than wheat ($P<0.001$). Wheat reached the maximum rate of gas production earlier than corn ($P<0.001$)



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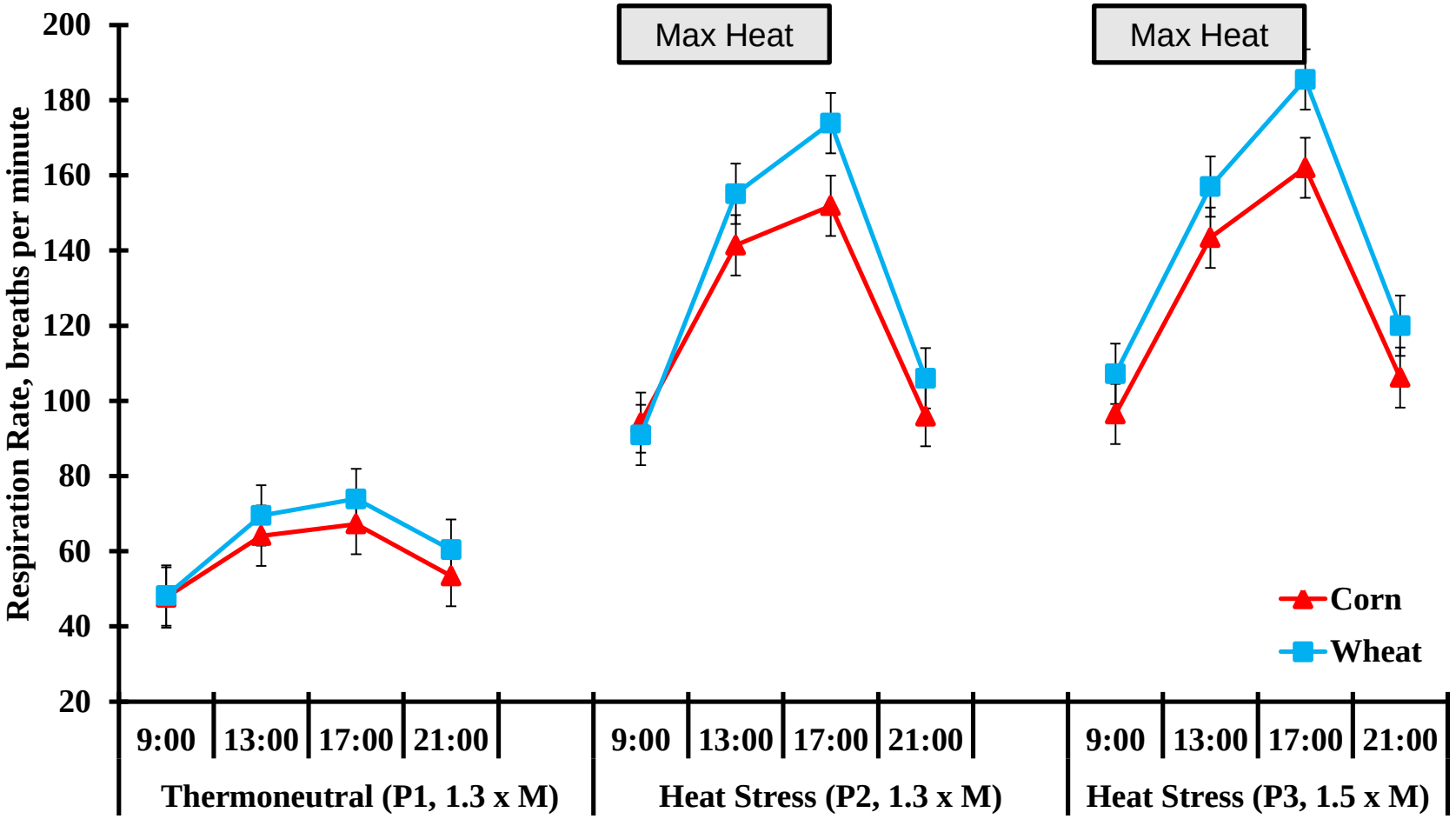
Heat stress increased RR (*P*<0.001) and corn-fed sheep had lower RR across periods (*P*<0.001)



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Corn -fed sheep showing lower RR at 38 C^0/30% RH

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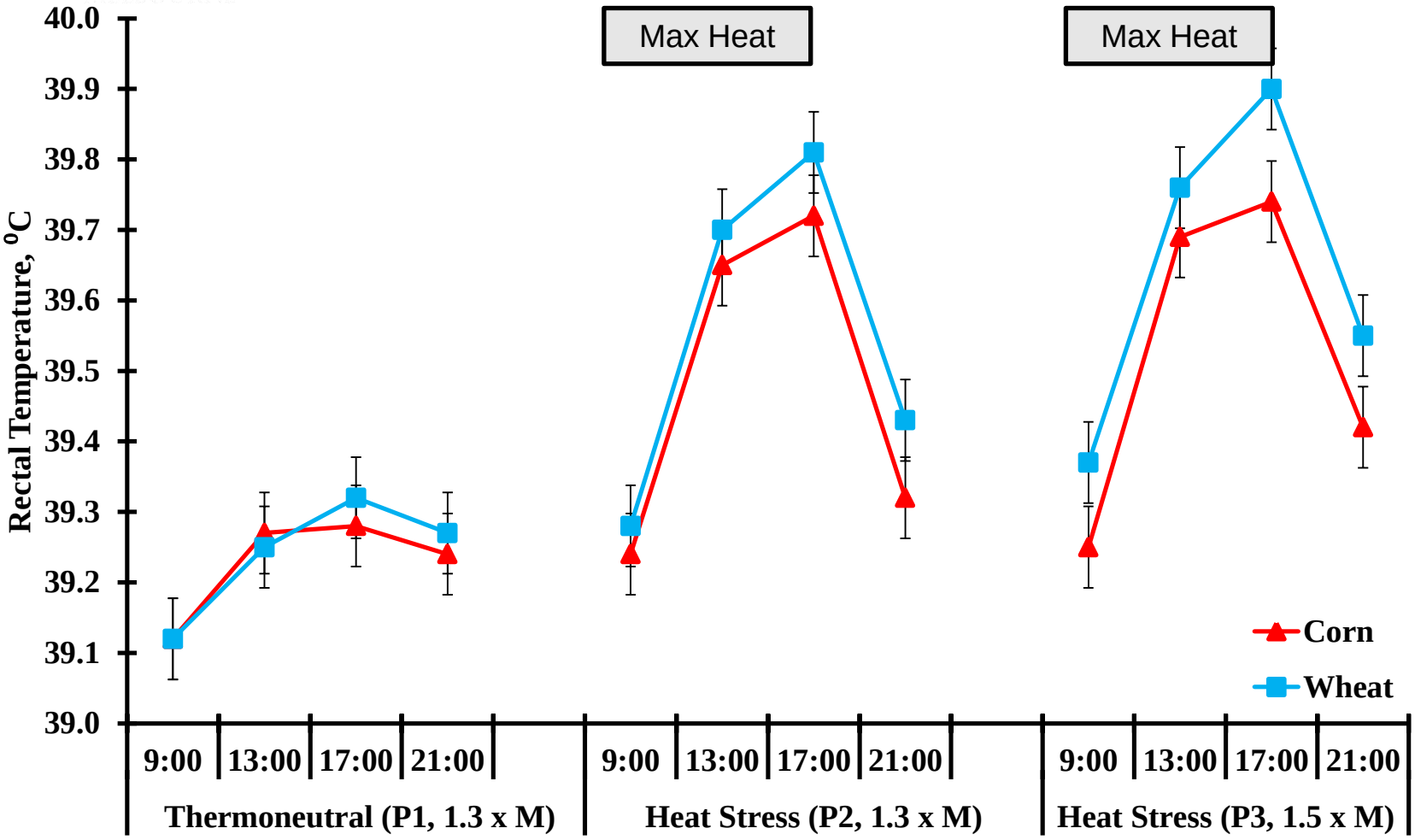
Heat stress increased RT (*P*<0.001), Corn-fed sheep had lower RT at high ambient temperature (*P*<0.001).



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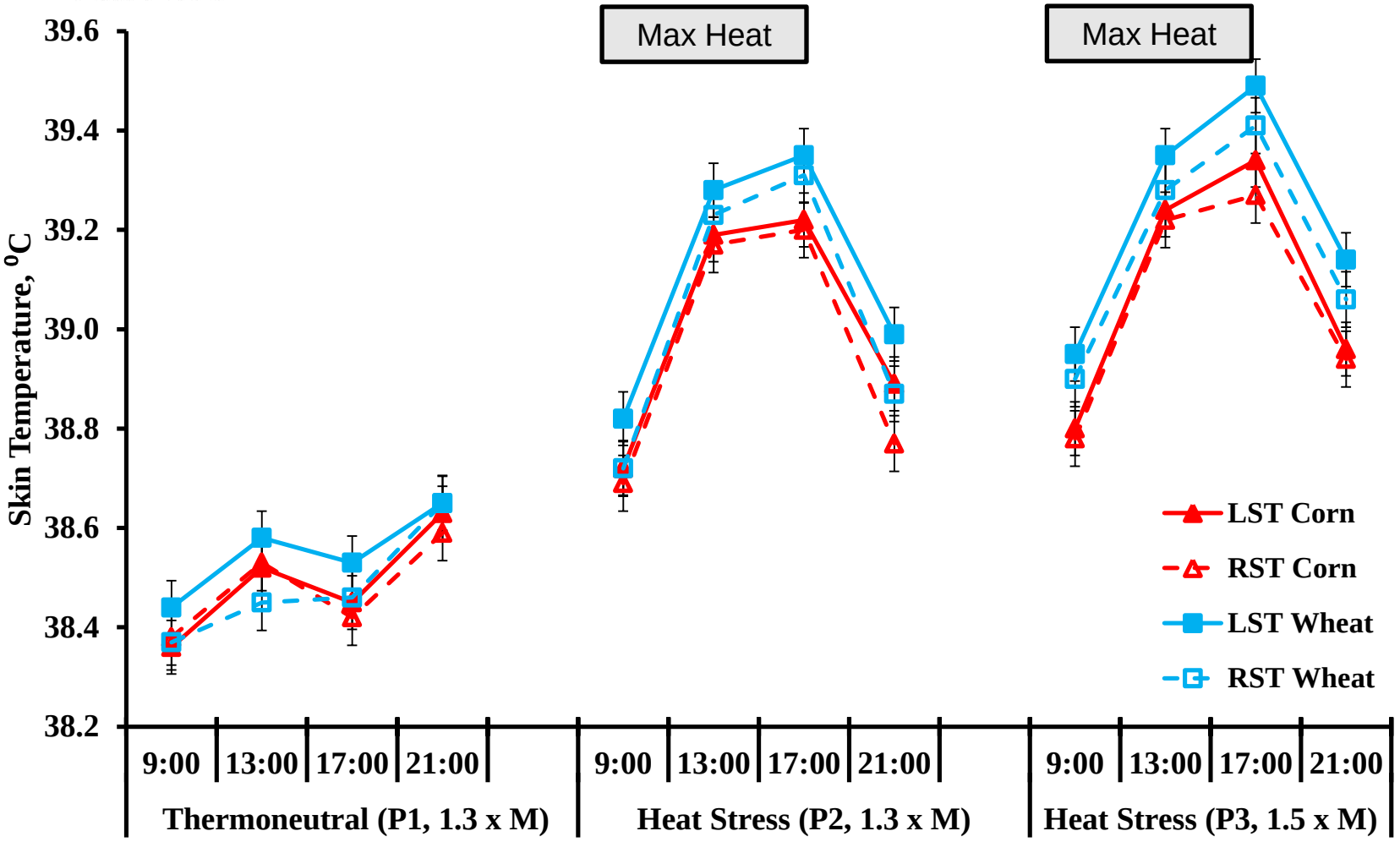
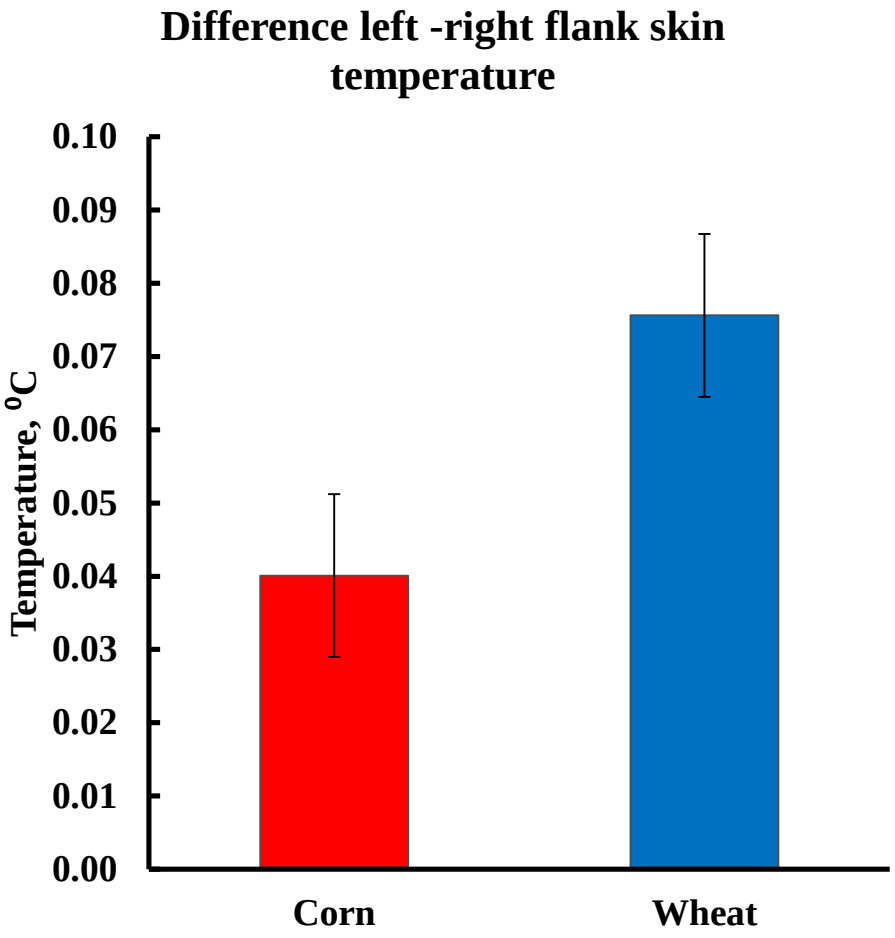
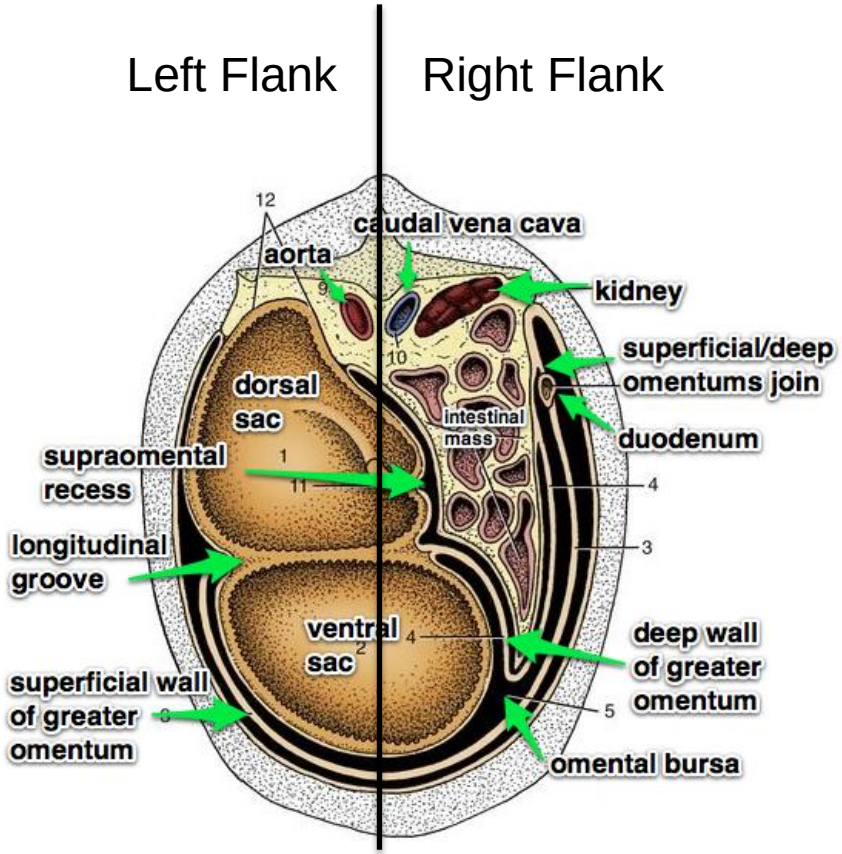
Skin temperature increased with heat stress (*P*< 0.001)
Corn- fed sheep had lower skin flank temperature (*P*<0.001)
LST was higher than RST (P<0.001)



Wheat-fed sheep had larger difference between left and right flank skin temperature (*P*<0.001)





http://bvetmed1.blogspot.com.au/2013/03/ruminant-abdomen-lecture-157.html
(Laue and Petersen, 1991; Montanholi et al., 2008)

CONCLUSION

- Corn grain had slower fermentation rate than wheat grain
- Feeding a corn-based diet reduced the total heat increment.
- Corn grain diet ameliorated the physiological responses negatively affected by HS in grain-fed sheep compared to dietary wheat.
- Higher feed intake increased the thermal load of the animals under HS.

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