



A dietary phytogenic solution mitigates heat stress indicators in pigs

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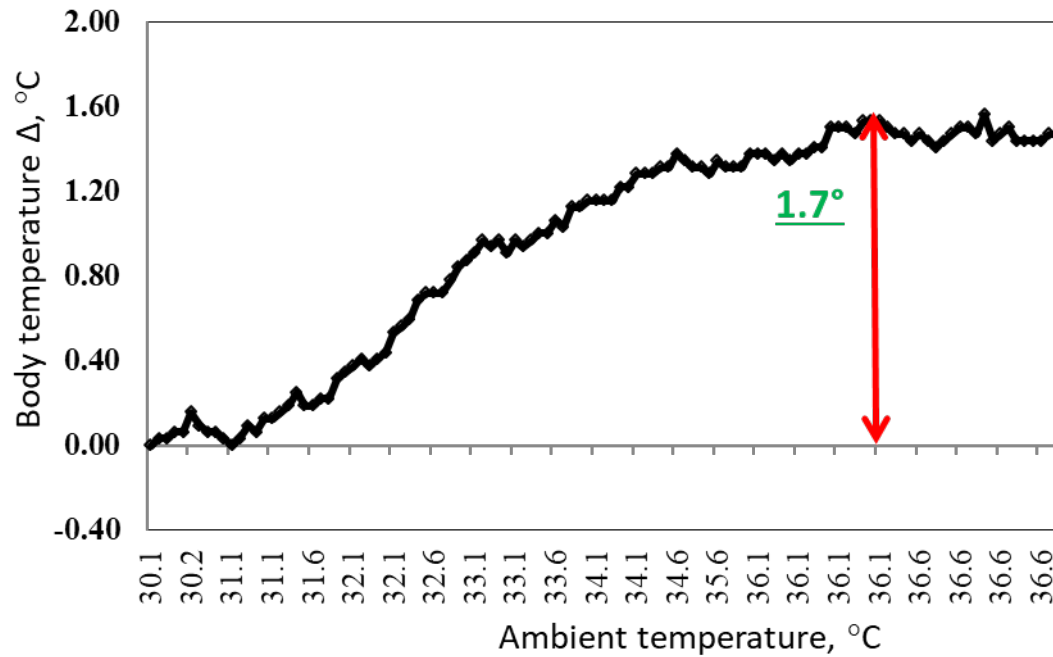


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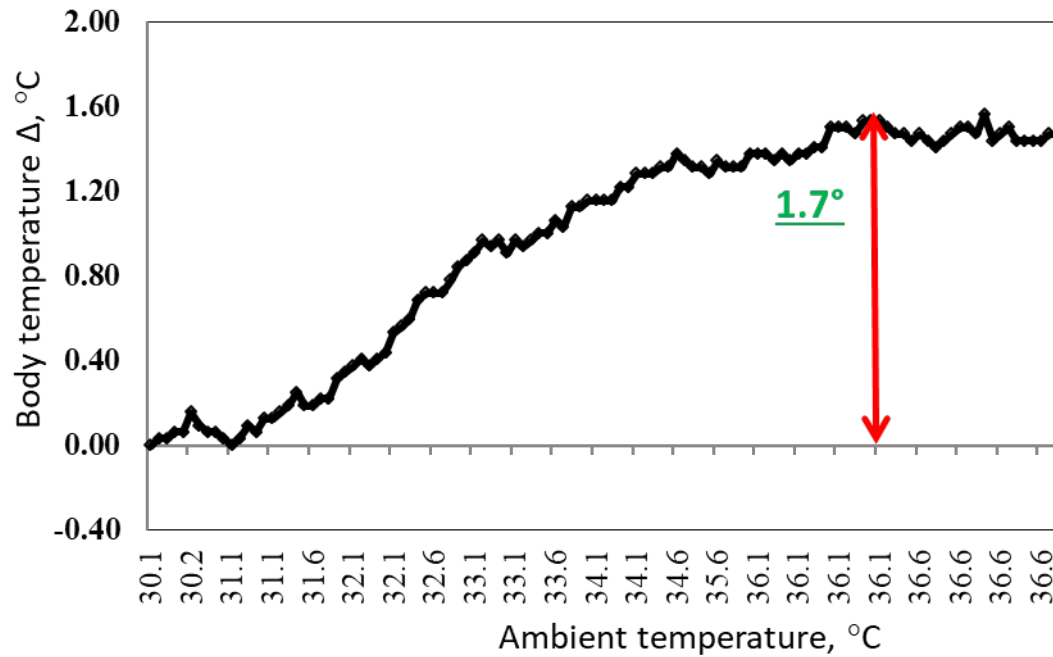
Background

- Exposing pigs to Heat stress (HS)
 - Reduces feed intake and growth rate
(Yu et al., 2010; Pearce et al., 2014)
 - Increases intestinal temperature
(Morales et al., 2017)



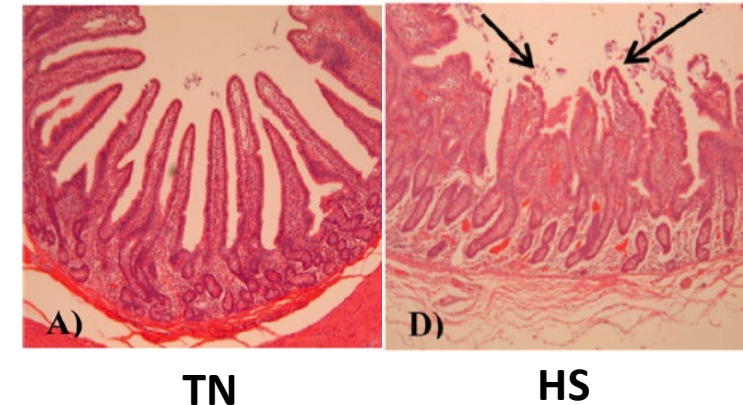
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Morales et al., 2019. Trans. Anim. Sci.

- Elevates peripheral blood flow to eliminate body heat
(Collin et al., 2001)
- But, blood flow to internal organs decreases
(Ogoh et al., 2013)
- Lower oxygen and nutrients supply to GIT
- Damage to intestinal epithelia

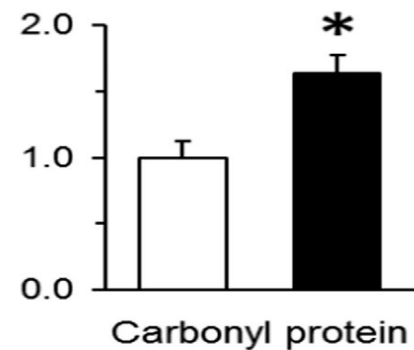
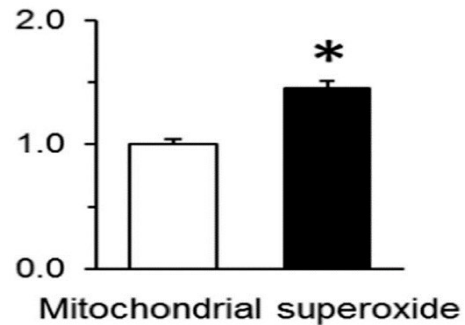


(Yu et al., 2010; Pearce et al., 2013; 2014).

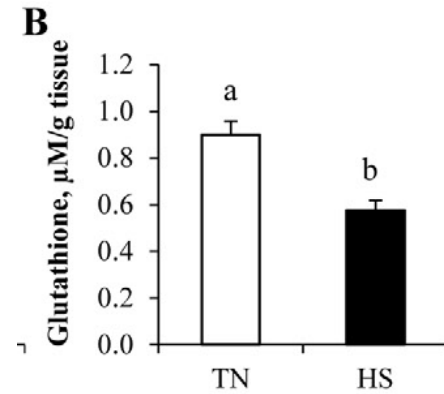
Pigs exposed to HS

Increase ROS production

(Kikusato and Toyomizu, 2013)



Decrease Glutathione concentration (Pearce et al. 2014)



Decrease mRNA abundance, synthesis and activity of SOD (Morrison et al. 2005)

- Increase oxidative stress, cell death and epithelia damage
- Reduce intestinal villi height

Depress Function and Integrity of Intestinal Epithelia

Capsaicin (burning effect)

- Capsaicinoids: Alkaloids present in chili peppers (*Capsicum spp.*)
- Plant-derived secondary metabolite
- Possesses antioxidant activity
- Signaling molecule (Azlan et al., 2022)
- Transient receptor potential cation channel V-1 (TRVP-1) agonist
 - TRVP-1 is a thermo sensor for thermo-regulation in mammals (Garami et al., 2020)
- Activation of TRVP-1
 - Lowers body temperature
 - Induces hypothermia via peripheral vasodilation (Inagaki et al., 2019)
 - Increases thermal tolerance (Szolcsányi, 2015)
- Effective in ruminants and poultry (Sakkas et al., 2023; An et al., 2022)
- But, no available reports in pigs

Objective

To evaluate the effect of supplementing diets with a *Capsicum spp.* based additive on body temperature, intestinal histomorphology, and antioxidant status of pigs exposed to heat stress.

Materials and Methods

- 42 pigs (21.6 ± 3.4 kg initial BW)
- 3 treatments (14 reps/treatment)
 - TN-Con: TN pigs fed control diet
 - HS-Con: HS pigs fed control diet
 - HS-Cap: HS pigs fed control diet + *Capsicum spp.* based feed additive
- **Climatic conditions**
 - **TN** ambient temperature controlled to 24 °C
 - **HS** exposed to natural variations on ambient temperature

Ingredient	Control
Wheat	84.26
Soybean meal, 48%	12.00
L-Lysine . HCl	0.54
L-Threonine	0.14
DL-Methionine	0.06
Phytogenic additive ¹	0.20
Ca carbonate	1.25
Di-Ca phosphate	0.80
Iodized salt	0.35
Vitamin Mineral Premix	2.80
¹ Phytogenic additive: Oleoresin and capsaicin principal active compounds	

Calculated content	Control
NE, Mcal/kg	10.1
SID Lys, %	0.99
SID Thr, %	0.62
SID Met, %	0.28

Materials and Methods

- Two periods: Adaptation and Experimental
 - Adaptation: all pigs under TN conditions from d1 to d7
 - Experimental: TN pigs remain in TN room but HS pigs were moved to the HS room from d8 to d15
- Feed and water *ad lib* during the 15-d trial
- Ambient temperature recorded every 15 min

Materials and Methods

Sacrifice

- 6 pigs/treatment
- 10 h overnight fast on day 8
- Sacrificed at 0700 h on day 9

Sample collection

- Blood
- Intestinal tissue
 - ~ 5 cm segment
- Liver and *Longissimus* muscle
 - ~ 200 mg

Materials and Methods

Activities of antioxidant enzymes in blood serum

- Catalase
- Glutathione peroxidase
- Superoxide dismutase
- Reduced Glutathione

Histomorphology of duodenum, jejunum, and ileum

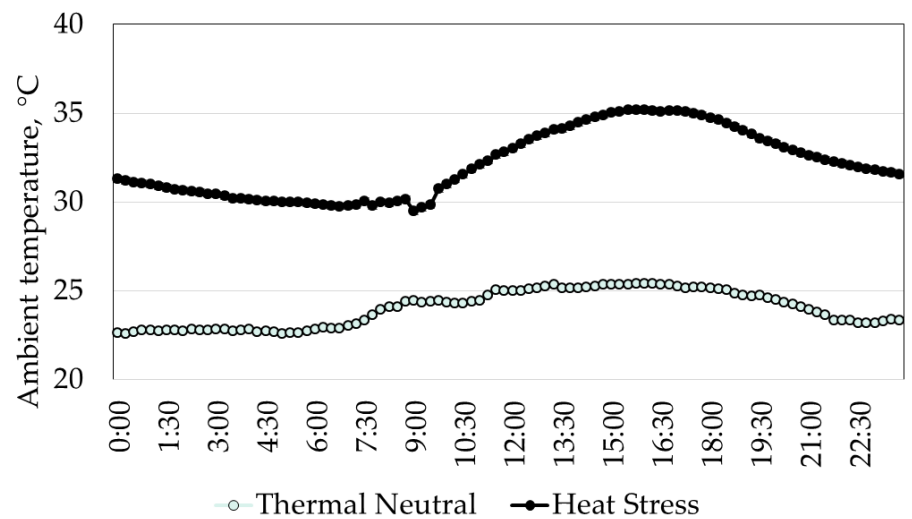
- Villi height
- Crypt depth
- Villi height : Crypt depth

Gene expression

- HSP90 in liver and muscle
- Myosin in muscle

Results

Ambient temperature



TN room

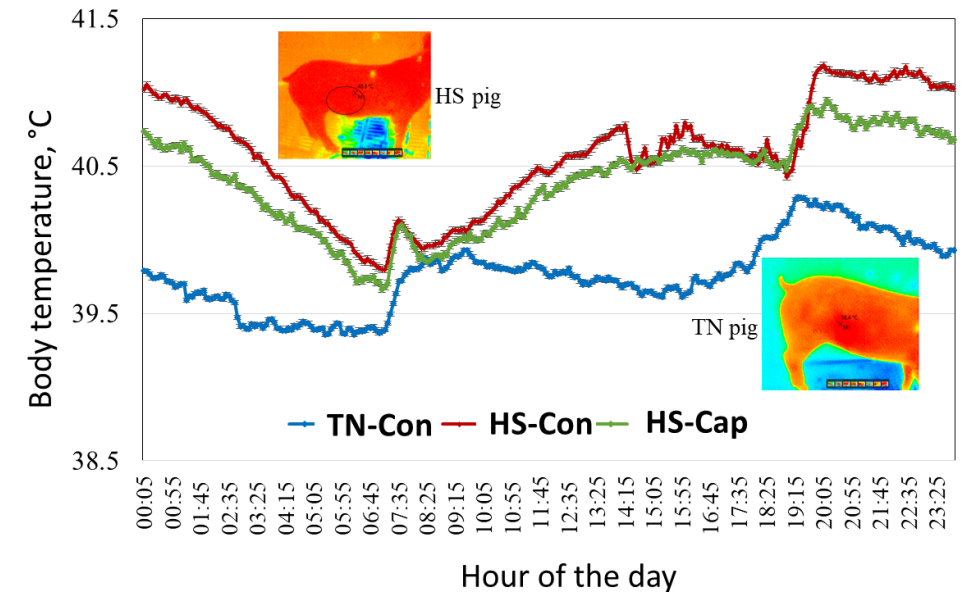
- 22 - 25 °C

HS room

- 30 - 36 °C

- TN zone growing pigs: 20 - 25 °C
- HS Pigs exposed to AT above 25 °C all the time = HS

Body temperature of HS pigs

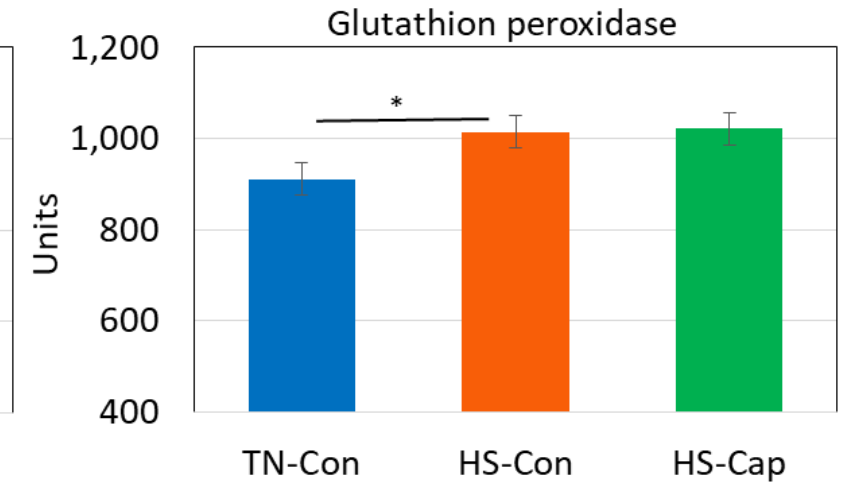
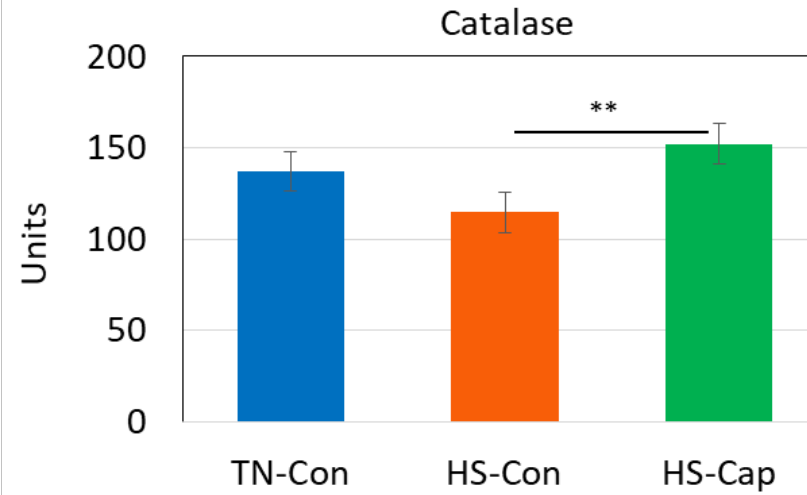
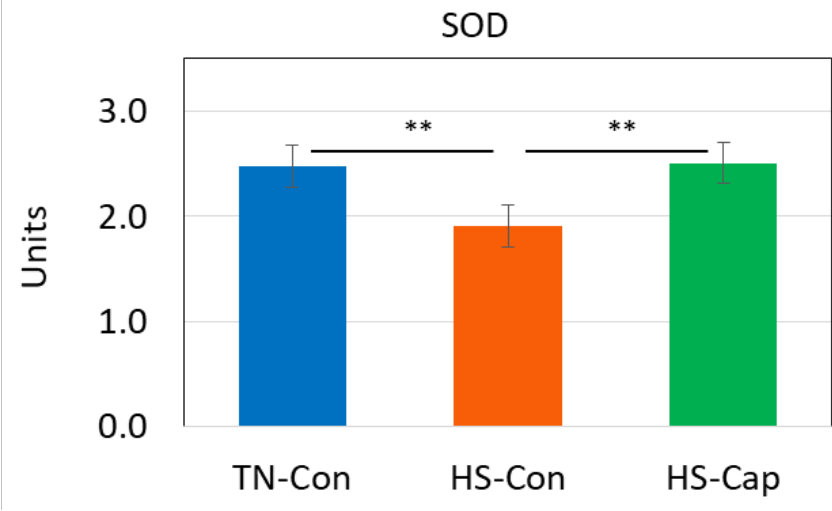


- BT followed AT pattern regardless of diet
- BT increment in HS-Cap pigs
 - Smaller than that in HS-C pigs from 19:00 to 02:00 h (warmest time of the day)

Activity of antioxidant enzymes

**P<0.05

* P<0.10



SOD

- HS decreased 30%
- Cap restored activity to TN level

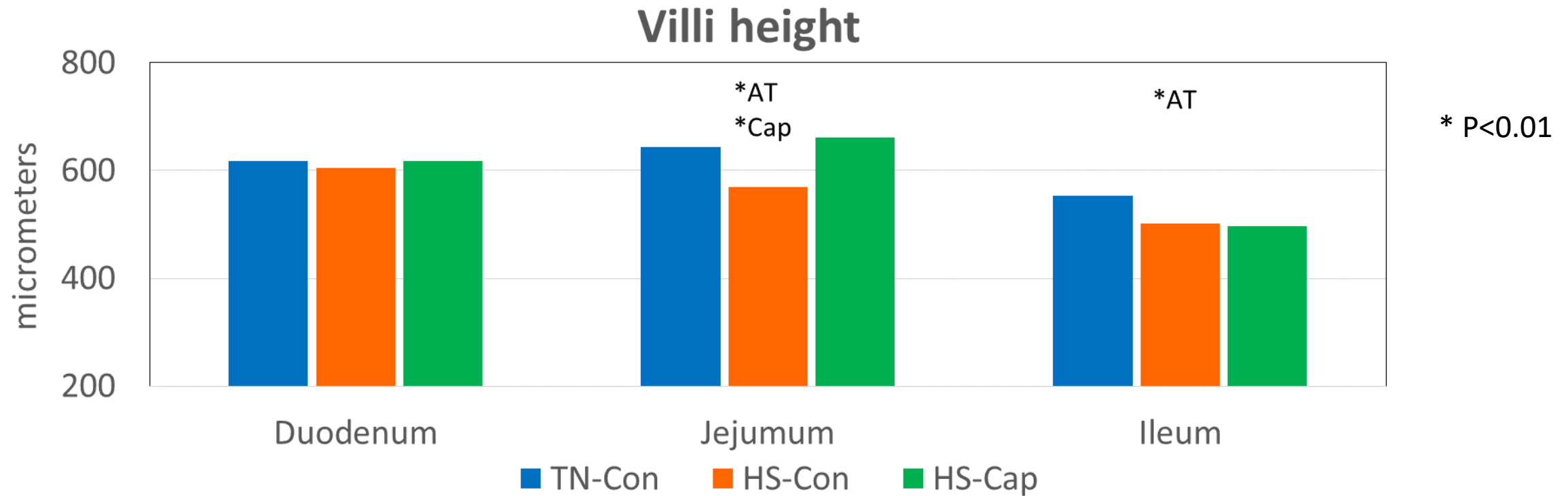
Catalase

- Under HS: Cap increased 33% the activity of Catalase

Glutathion peroxidase

- HS tended to increase 12%

Intestinal histomorphology



Duodenum

No effect of AT nor additive

Jejunum

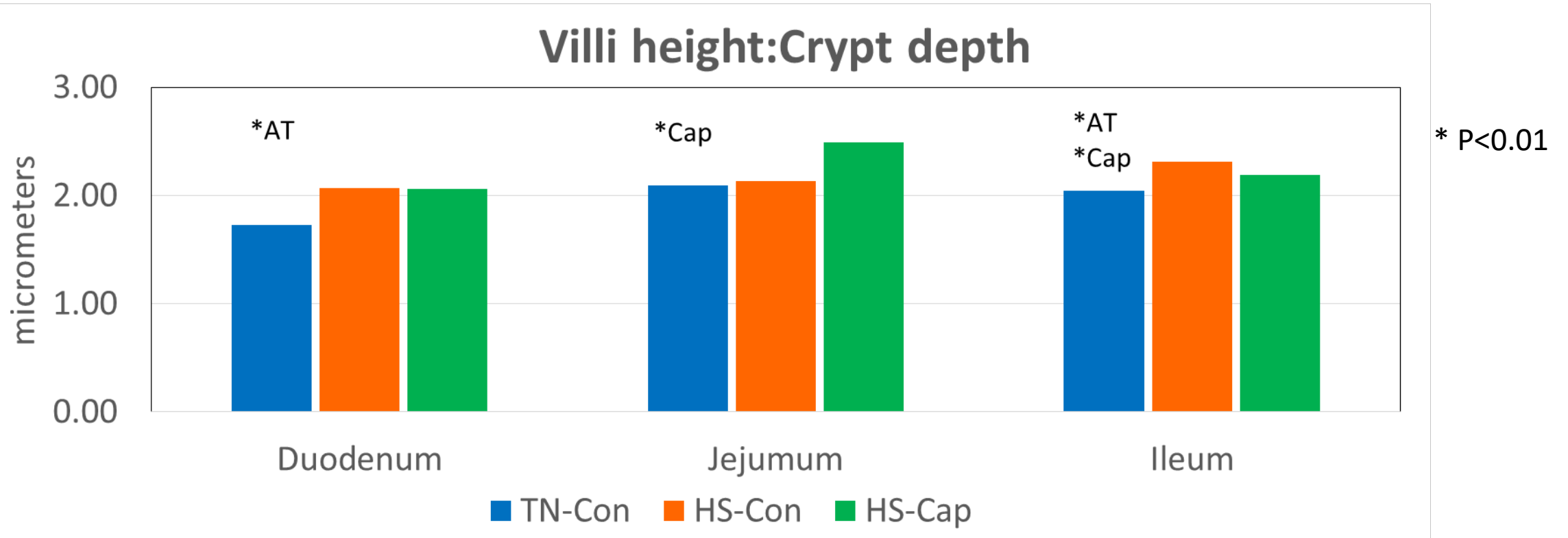
HS decreased 12%

Under HS: Cap increased 16%

Ileum

HS decreased 10%

Intestinal histomorphology



Duodenum

HS increased 20%

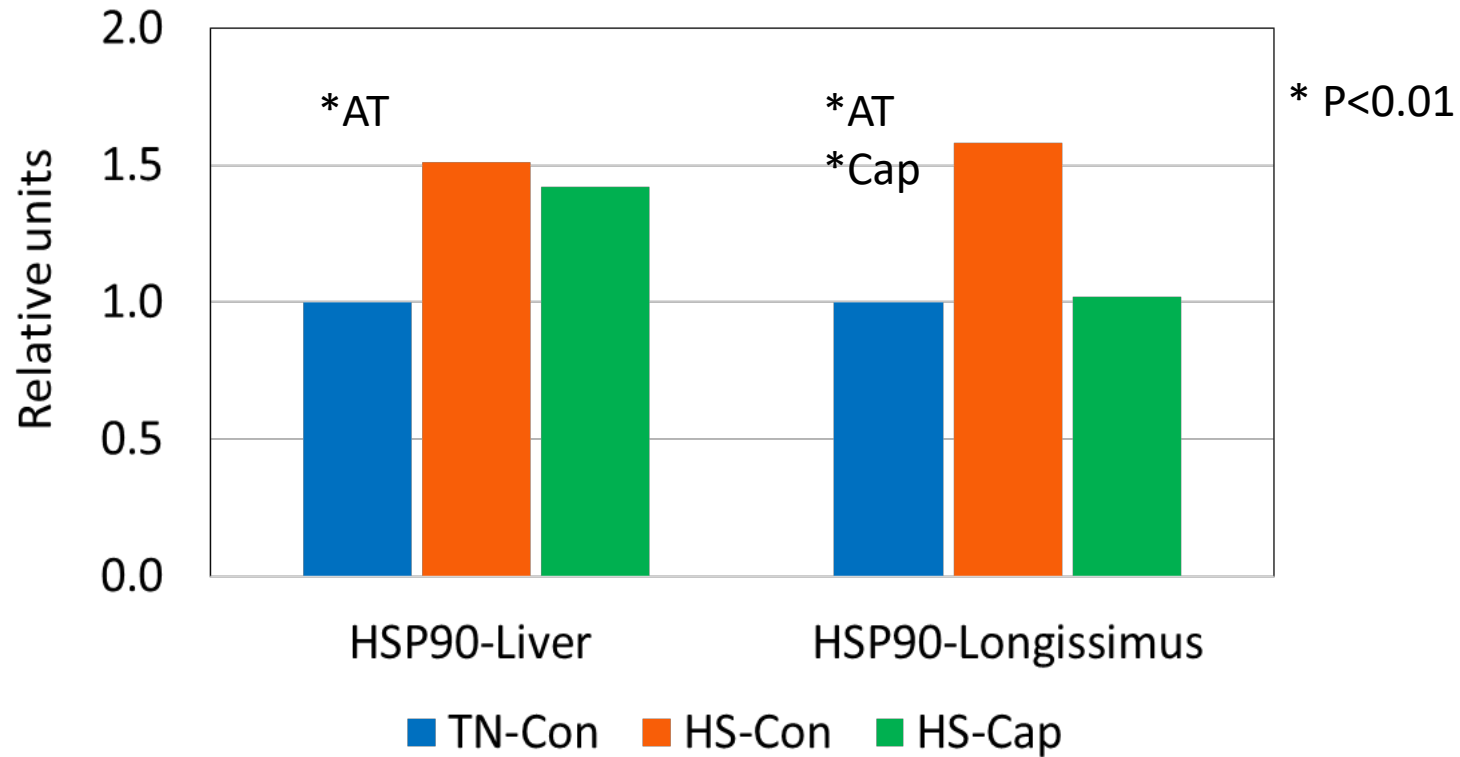
Jejunum

Under HS:
Cap increased 20%

Ileum

HS increased 13%
Under HS: Cap decreased 5%

Gene expression



HSP90-Liver

HS increased 50%
the expression of
HSP90

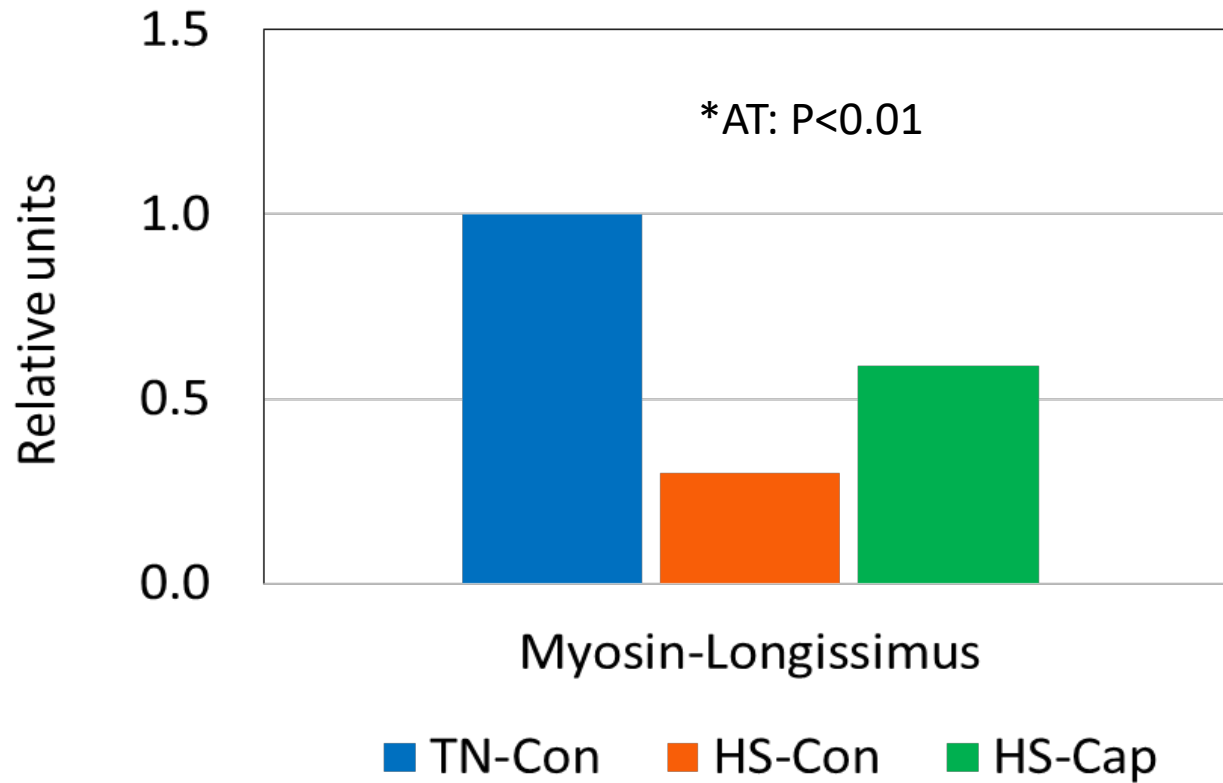
HSP90-Longissimus

HS increased 50% the
expression of HSP90

Under HS:

Cap restored HSP90 expression
to TN level

Gene expression



Myosin-Longissimus

HS decreased to 30% the expression of myosin

Cap: Partially restored TN expression

Conclusions

Pigs exposed to HS show:

- Increased body temperature
- Altered intestinal histo-morphology
- Depressed antioxidant status, specifically SOD and Catalase
- Affected expression of HSP90 and myosin

Supplementation of the diet with the Capsaisin based additive:

- Reduced body temperature in HS pigs during the warmest time of the day
- Ameliorates the negative effects on the intestinal histology of HS pigs
- Helped to improve antioxidant status of pigs under HS conditions
- Affected gene expression in muscle of HS pigs

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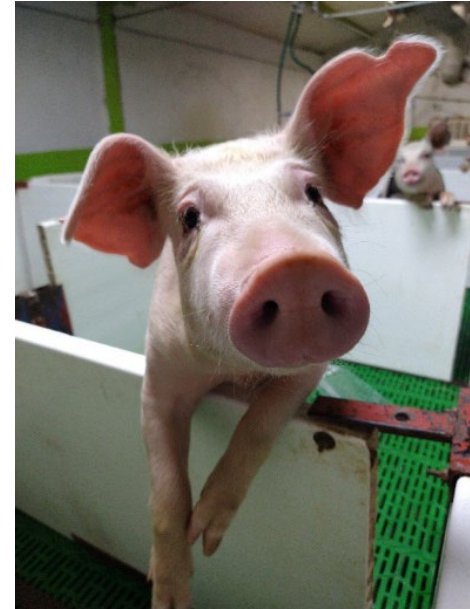


CONAHCYT - México



Thank you

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animals

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Article

A Capsaicin-Based Phytogenic Solution Improves Performance and Thermal Tolerance of Heat-Stressed Growing Pigs

Miguel Cervantes ¹, Panagiotis Sakkas ², Moisés Soto ¹, Alejandra Jaquelin Gómez ¹, Reyna L. Camacho ¹, Néstor Arce ¹, Nicolas Quilichini ³ and Adriana Morales ^{1,*}

Preview:

A dietary phytogetic solution mitigates heat stress indicators in pigs

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This study aims to corroborate if enhancements in performance and reductions in body temperature in heat-stressed (HS) pigs, supplemented with a 0.2% Capsicum spp.-based phytogetic solution (PHY) (Morales et al., 2023), are associated with changes in thermal tolerance markers. Forty-two pigs were assigned to three treatments: thermoneutral pigs on a control diet (TN-C), and pigs subjected to HS fed either PHY-supplemented (HS-PHY) or control diets (HS-C). After a 8-day experimental period, serum antioxidant enzyme activity, intestinal histomorphology, gene expression of HSP90 in the liver and muscle, and myosin in muscle were assessed. Superoxide dismutase activity was lower in HS-C pigs vs. TN-C and HS-PHY pigs ($P < 0.05$), being similar between TN-C and HS-PHY groups. Catalase activity was similar in TN-C and HS-C pigs, but higher in HS-PHY pigs compared to HS-C pigs ($P < 0.05$). HS-C pigs had shorter jejunum villi and deeper crypts than both HS-PHY and TN-C ($P < 0.01$). Expression of HSP90 in the liver was tentatively higher in both HS-C and HS-PHY pigs compared to TN-C pigs ($P > 0.10$). In muscle, HSP90 expression was significantly higher in HS-C pigs than in both TN-C and HS-PHY pigs ($P < 0.05$), but similar between TN-C and HS-PHY pigs ($P > 0.10$). Muscle myosin expression was lower in HS-C compared to TN-C ($P < 0.05$), with no difference between HS-PHY and TN-C pigs ($P > 0.10$). In conclusion, dietary PHY supplementation enhanced anti-oxidant enzyme activity, reduced HSP90 expression in Longissimus dorsi muscle, and elevated jejunal villus height compared to HS-C pigs, reaching levels akin to TN-C pigs, explaining the restored growth previously observed in HS-PHY pigs.

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Keywords: Feed supplements and additives, Adaptation and stress, Robustness

Species (mainly) related: Pigs

Discipline (mainly) related: Nutrition

Presentation: Theater

Session: 21 - Heat stress in pig and poultry production: consequences and strategies to cope with the consequence of the global warming