Identification of molecular mechanisms of stress-resistance in turkeys to improve meat quality

Gale Strasburg, Ph.D.

Department of Food Science and Human Nutrition

Michigan State University

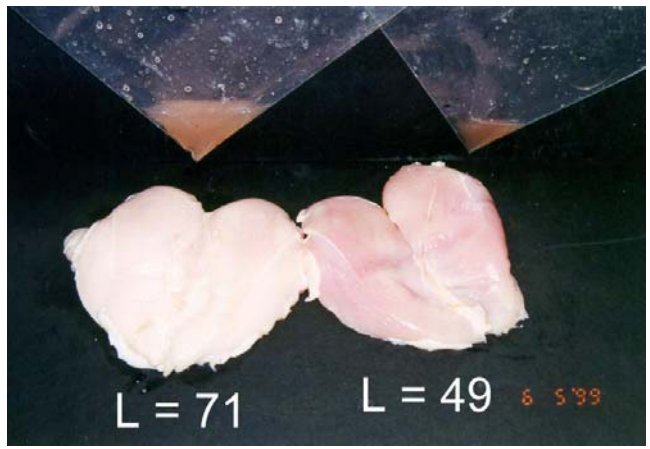
USDA-CREES: 2005-01326

FOOD SCIENCE
HUMAN NUTRITION
MICHIGAN STATE
UNIVERSITY

CSREES
EDUCATION
USDA
RESEARCH · EXTENSION

Pale, Soft, Exudative (PSE) Meat

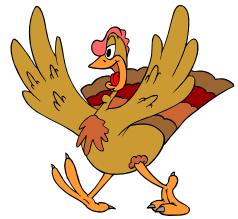
- A meat quality defect, originally observed in pork
- PSE meat characteristics:
  - Abnormally light color
  - Flaccid texture
  - Poor water holding capacity



- Higher frequency in growth-selected animals
- Higher frequency in summer season

Hypothetical Mechanism for the Development of PSE Turkey Meat

Birds encounter heat stress



↓

Black box

↓

Elevated muscle $[Ca^{2+}]_{res}$

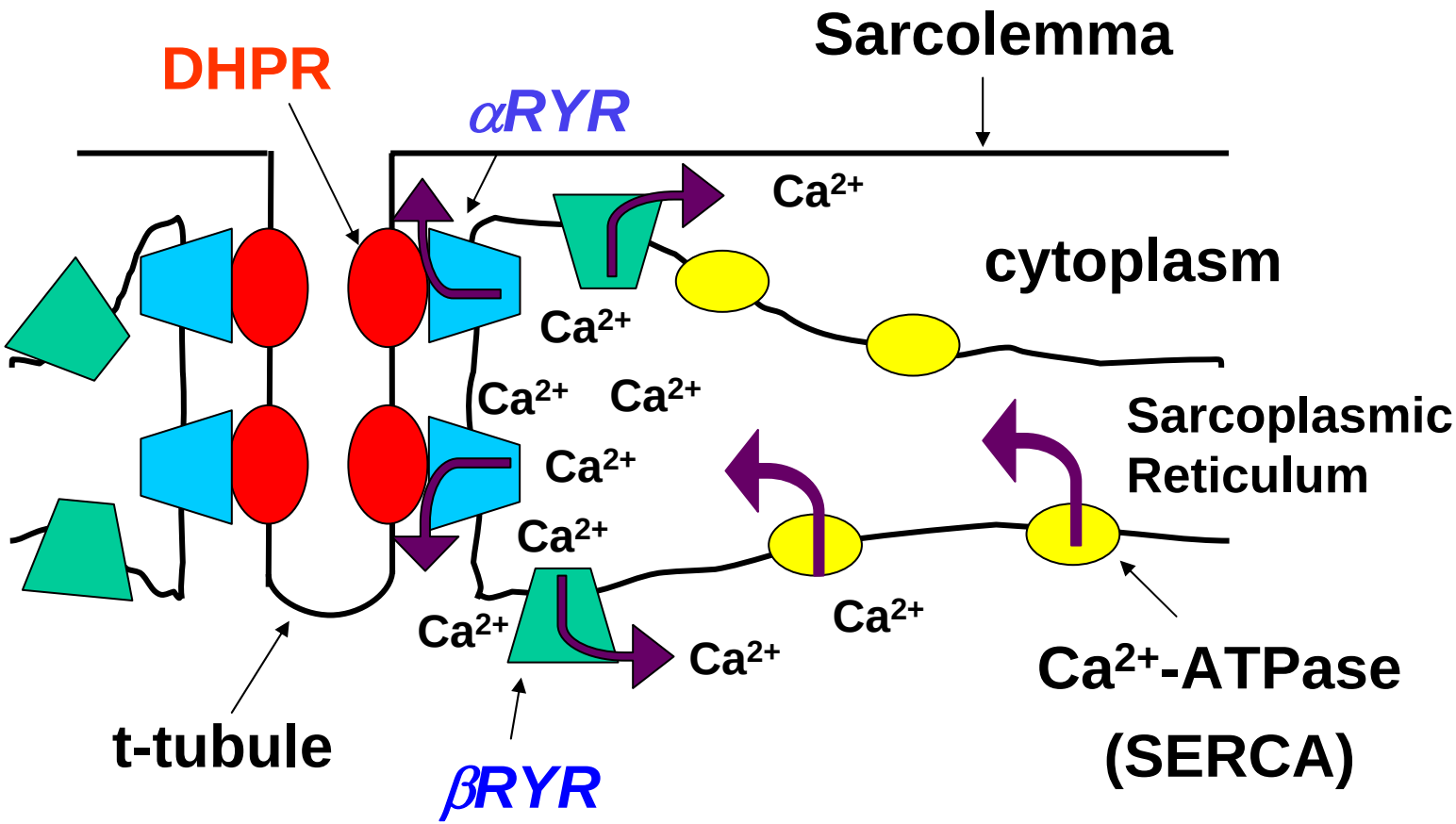
↓

Muscle hypermetabolism & accelerated glycogenolysis

↓

Development of PSE turkey meat

Calcium Regulation in Avian Skeletal Muscle



Factors affecting Ca^{2+} regulation

- Primary structure of RYR changed by point mutation or alternative splicing
- Presence of RYR channel activator: halothane, caffeine, thyroid hormone
- RYR and SERCA expression regulated by the thyroid hormone status

Thyroid Hormone Regulation

Normal	Increased basal metabolic rate, O_2 consumption and heat production
Hypothyroidism	Sensitive to cold
Hyperthyroidism	Sensitive to heat

Thyroid hormone levels could influence Ca^{2+} homeostasis in muscle by:

- affecting RYR and SERCA *activity*
- affecting RYR and SERCA *expression*

Objectives

- Investigate thyroid hormone levels influenced by heat stress and the influence of thyroid state on expression and functional properties of RYR
- Investigate alternatively spliced αRYR transcript variants through heat stress treatment
- Evaluate post-heat-stressed turkey meat quality

Turkey resources:

RBC2 (genetic unimproved, random bred line)

Commercial (growth-selected line)

Experimental Design

Turkeys: RBC2 line- M & F
Commercial line- M & F

Heat stress condition: 12 hours of 95°F, 12 hours of 80°F

Heat stress treatments:

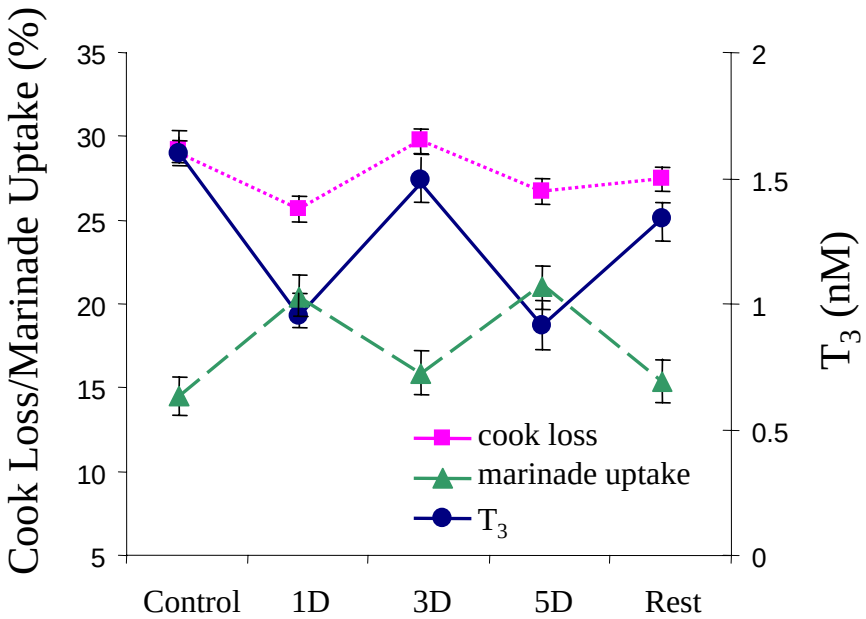
Group	Control	1D	3D	5D	Rest
Duration (h)	0	24	72	120	168 stressed 168 rest

Sample collections:

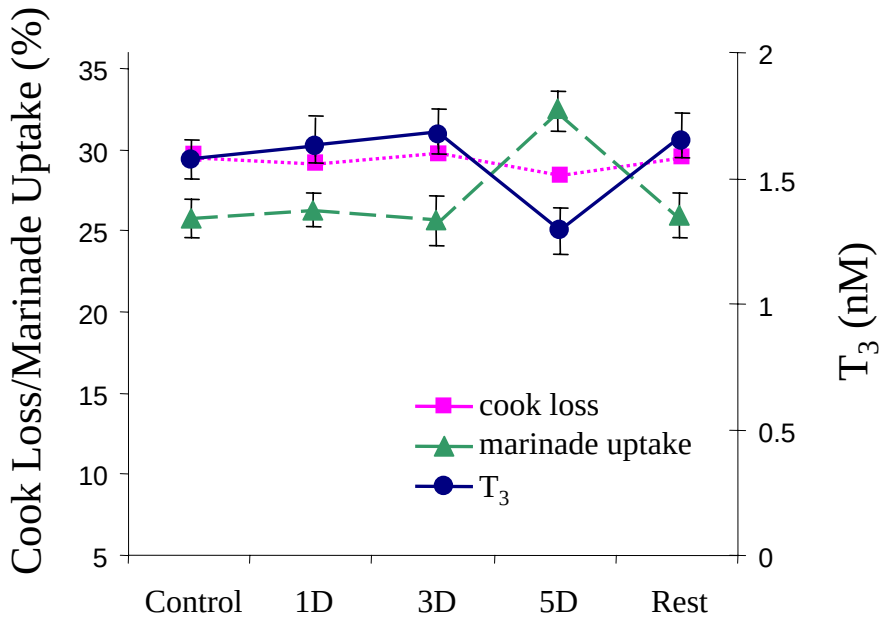
blood (thyroid hormone-T3 & T4)
breast muscle (RNA, RYR purification)
breast muscle ($pH_{15\ min}$, color-L*, drip loss, cook loss, marinade uptake)

Thyroid hormone and meat quality in response to heat stress

- Thyroid hormone response in heat-stressed birds:
  commercial birds fluctuated.
  RBC2 birds were stable until stressed for 5D;
- Meat quality in heat-stressed birds: most noticeable in cook loss & marinade uptake



Commercial line

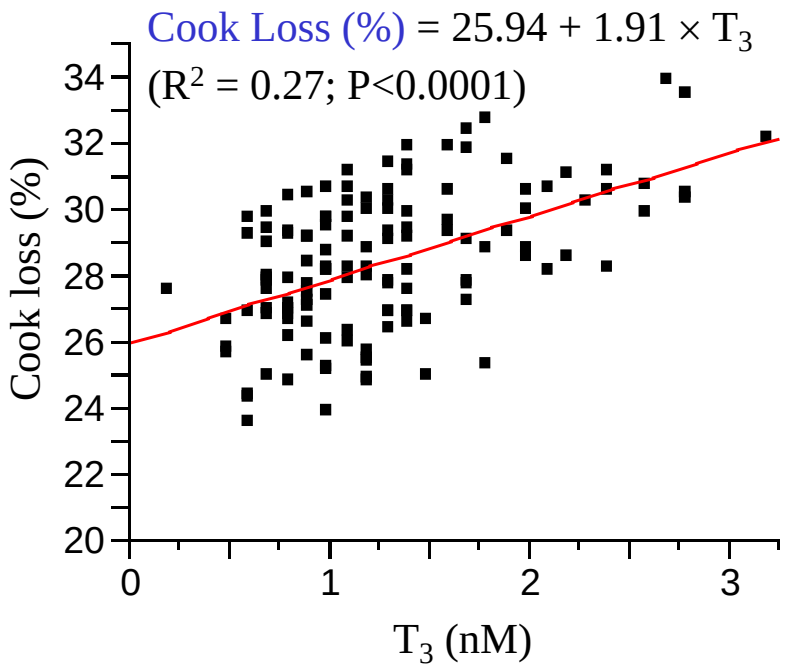


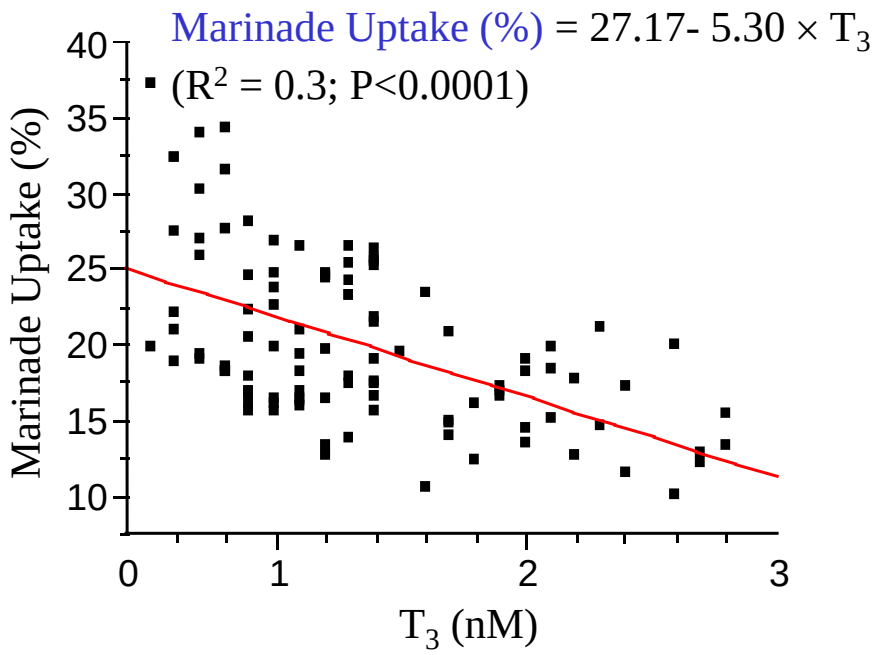
RBC2 line

Thyroid hormone and meat quality in response to heat stress

- Variations of cook loss and marinade uptake followed closely to the variations of T_3 in birds of both lines

Commercial line

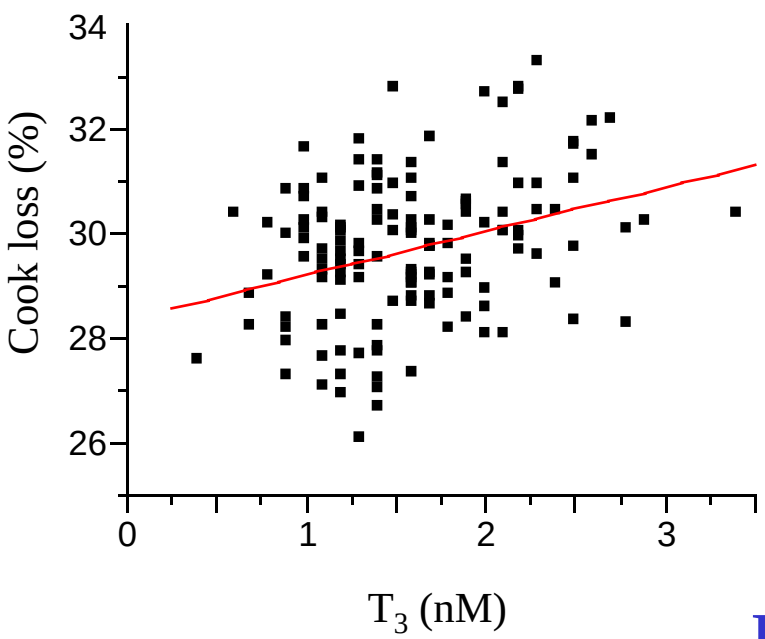




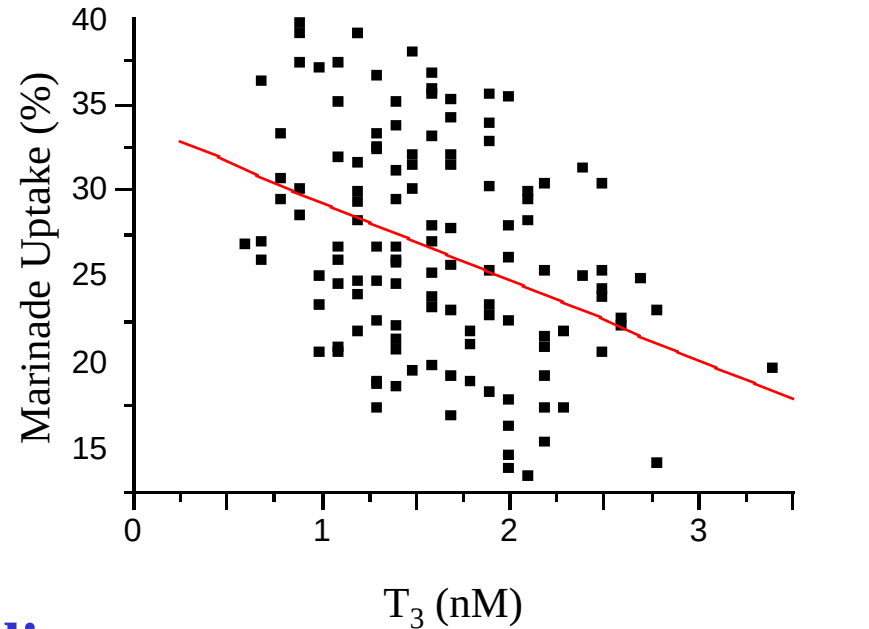
Thyroid hormone and meat quality in response to heat stress

- Variations of cook loss and marinade uptake followed closely to the variations of T_3 in birds of both lines

Cook loss (%) = 28.36 + 0.84 × T_3
(R^2=0.11; P<0.0001)



Marinade Uptake (%) = 33.98 - 4.58 × T_3
(R^2=0.14; P<0.0001)



RBC2 line

Conclusions

- Growth selection did not have a negative impact on meat quality, but meat quality from commercial birds was less consistent when birds were heat-stressed
- Birds with stable thyroid hormone response to heat are likely to produce consistent fresh turkey meat and further processed turkey products.

Questions