Final Technical Report

FCEB Project #31

Percentage completion of project deliverables: 100%

<u>Title</u>: **Learning from Brahman cattle how to dissipate heat in a hot world**

<u>Principle Investigator</u>: **Raluca G. Mateescu**[1]* (PD/PI)
[1]Department of Animal Sciences, University of Florida, Gainesville, FL 32611-0910.
*Email: raluca@ufl.edu; Tel: 352-392-2367

<u>Relevance to Florida Cattle Industry:</u> Our **long-term** goal is to provide the cattle industry with knowledge and tools needed to increase tolerance to heat stress while simultaneously allowing for increased efficiency of production, reproductive performance, quality and nutritional value of beef. Favorable genetic variants conferring superior heat tolerance to *Bos indicus* cattle are present and segregating in *Bos indicus* x *Bos taurus* crossbred populations selected for performance in tropical environments.

This proposal addresses the "*Bos Indicus* Genetics" research priority. The major benefit of using Brahman genetics in a herd is the increased adaptability to the tropical and subtropical environment provided by the Brahman genetics. Under heat stress, cattle lose heat primarily via cutaneous evaporation at the skin-hair coat interface. Many factors affect the efficiency of evaporative cooling including sweating capacity, sweat gland properties and hair coat properties. Sweating is an important method of heat loss. When the ambient temperature exceeds 86°F, **85%** of the heat loss is achieved through sweating. Animals vary in their ability to dissipate heat and, therefore, in their ability to cope with heat stress, and this variability has a genetic component. Our work aims to develop effective strategies to improve the ability to cope with heat stress which is imperative to enhance productivity of the livestock industry and secure global food supplies. However, selection focused on production and ignoring adaptability results in beef animals with higher metabolic heat production and increased sensitivity to heat stress.

<u>Objectives:</u>
This proposal had four objectives:
1) Select a new set of 250 skin biopsy samples from a large population available. Biopsies will be selected to represent animals with extreme phenotypic characteristics for thermotolerance and sweating abilities.
2) Process histology slides from the 250 selected skin biopsies and measure skin characteristics including sweat gland area.
3) Sequence the entire genome of these animals to provide a higher resolution of the genomic architecture.
4) Identify genetic markers associated with increased sweating ability. This will pave the way for future research to develop genetic tests to select animals with higher potential for climatic resilience without negative effects on production.

Results

A large population of Brahman influenced beef cattle (more than 2,000 animals) was developed through previous projects where body temperature data during hot and humid summer conditions was recorded and skin biopsies were collected. Based on the available data, we identified 400 animals with extreme traits for body temperature under high temperature-humidity index: 200 most heat tolerant and 200 most heat sensitive.

A skin biopsy sample was collected using a 0.6 cm diameter punch biopsy instrument (Biopsy Punch, Miltex Inc., PA) and fixed in 10% formalin for approximately 24 h. Samples were dehydrated in 70% ethanol and infiltrated in liquid paraffin and stored. Selected samples were sectioned and stained at the UF Molecular Pathology Core. Sections were cut on a microtome with a thickness of 7 um, and sections were placed on slides, then stained with Harros-Eosin Hematoxylin. All histological sections were analyzed from digitized images obtained from a Nikon T3000 inverted phase microscope equipped with image capture equipment (DMZ1200F with NIS Image Elements software). Images were obtained with the microscope in 40 X, and analyzed with ImageJ software. Sweat gland area (mm^2) and sweat gland depth as the distance from the top of the sweat glands to the skin surface (mm) were determined from a constant 4.6 mm^2 cropped image area.

Tremendous differences in skin properties are evident when comparing the skin histology of Brahman and Angus, with Brahman having larger sweat glands located closer to the skin surface than Angus cattle (**Figure 1**).
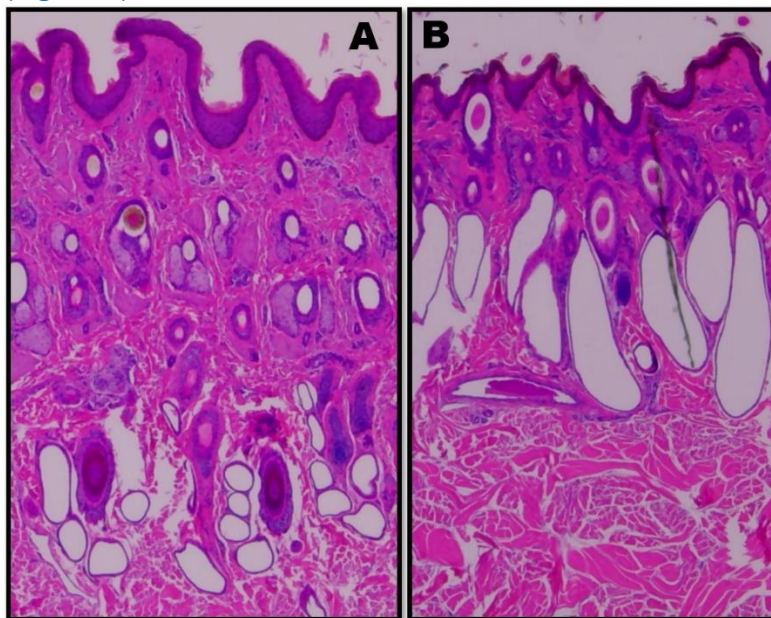

Figure 1. Vertical skin sections of an Angus (A) and a Brahman (B) heifer showing Angus cattle have deeper and smaller sweat glands (SWG) compared to Brahman cattle which have larger sweat gland area and sweat glands closer to the surface of the skin.

This is, to our knowledge, the first study reporting an extensive investigation of skin histology properties in a multibreed Angus-Brahman heifer population. Heat loss adaptations at the skin

level are anticipated to have a negligible effect on productivity, thereby presenting an excellent opportunity to select for animals with superior thermal adaptation and food production abilities. In this study, the breed group had a statistically significant effect on every skin property except dermis thickness. Compared to Angus cattle, Brahman cattle had a substantially thinner and longer epidermis (**Figure 2**), a thinner dermis, larger sweat gland areas, longer sweat glands closer to the skin's surface, smaller sebaceous gland area, and more sebaceous glands. Equally important, these differences are accompanied by high degrees of variation within each breed, which suggests that selecting for these skin traits may enhance beef cattle's capacity for heat exchange.
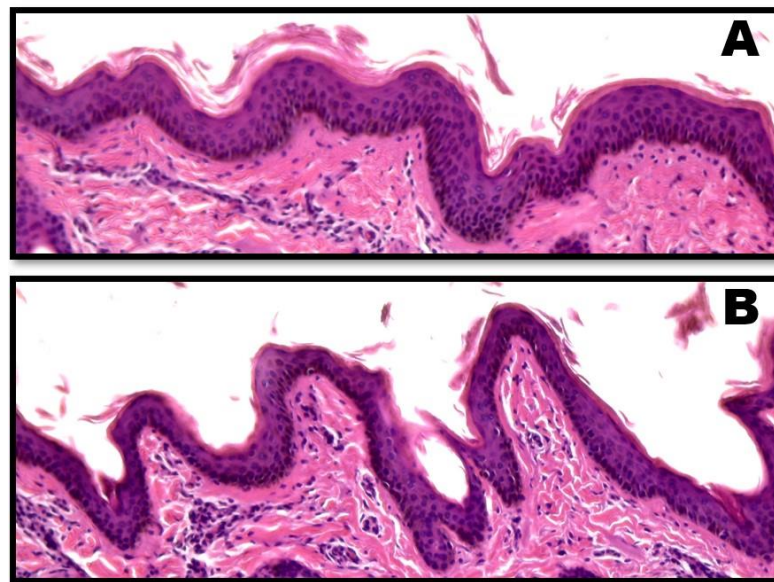

Figure 2. Vertical skin sections of an Angus (A) and a Brahman (B) heifer showing the epidermis. Angus cattle had thicker and smoother epidermis while Brahman cattle had thinner and more wavy epidermis.

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Invoice Date:	08/15/2024
Invoice Period:	05/01/2024 - 07/31/2024
Principal Investigator:	Mateescu,Raluca
Award Begin Date:	10/30/2023
Award End Date:	07/31/2024

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Sponsor Award ID:	31
Award Title:	Learning from Brahman cattle how to dissipate heat in a hot world
Award Amount:	$41,886.00

Invoice #	I000130491
UF Award #	AWD15778
Primary Project #	P0324530
Primary Department:	60090000
Current Invoice Amount:	$29,870.71

Description	Current	Cumulative
Personnel - Salary	$5,296.54	$9,612.23
Personnel - Fringe Benefits	$624.94	$1,134.16
Tuition	$0.00	$4,038.57
Materials and Supplies	($433.91)	$1,430.34
Contractual Services	$21,182.70	$21,182.70
Direct Cost	$26,734.44	$37,462.17
Facilities and Administrative Costs	$3,200.44	$4,487.76
Total	$29,870.71	$41,885.76

For billing questions, please call 352.392.1235
Torres,Kannika S kannika@ufl.edu
Please reference the UF Award Number and Invoice
Number in all correspondence

By signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate, and the expenditures, disbursements and cash receipts are for the purposes and objectives set forth in the terms and conditions of the federal award. I am aware that any false, fictitious, or fraudulent information, or the omission of any material fact, may subject me to criminal, civil, or administrative penalties for fraud, false statements, false claims or otherwise. (U.S Code Title 18, Section 1001 and Title 31, Sections 3729-3730 and 3801-3812).

Kannika Torres

Certifying Official

Payment History	
Cumulative Invoices:	$41,885.76
Payments Received:	$12,015.05
Outstanding Balance:	$29,870.71
Note: Outstanding balance includes current invoice amount	

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Project ID	Deptid	Department Name		Current	Cumulative
P0324530	60090000	AG-ANIMAL SCIENCES		$29,870.95	$41,886.00