

United States Department of Agriculture
Project Initiation

Project Data for Accession Number 1031367

Project Title

Laying Hen Performance: Antioxidant Carotenoids and Heat Stress

Project Details

Sponsoring Institution National Institute of Food and Agriculture	Project Status ACTIVE
Funding Source NIFA Non Formula	Grant Year 2023
Grant No. 2023-77045-41007	Cumulative Award Amt. \$460,455.00
Proposal No. 2023-06327	Multistate No. (N/A)
Project Start Date Sep 01, 2023	Project End Date Aug 31, 2026
Program Code [LHTR] Laying Hen and Turkey Research Program	

Project Director

Rocheford, E.

Recipient Organization

NUTRAMAIZE LLC
1281 WIN HENTSCHEL BLVD
West Lafayette, INDIANA 479064182

Performing Department

(N/A)

Non Technical Summary

Heat stress is a major health and productivity challenge facing the laying hen industry. Various physiological changes occur in laying hens in response to heat stress. One of the major consequences is oxidative stress, which includes the production of excess free radicals. Therefore, increasing the antioxidant intake of birds has been proposed as a mitigation strategy for heat stress by addressing oxidative stress. Antioxidant activities include neutralizing free radicals, reducing their ability to cause cellular damage. A number of antioxidant compounds have demonstrated beneficial effects; however, to date, there have been no investigations of xanthophyll carotenoids. Xanthophylls are potent antioxidants and anti-inflammatory agents that have high physiological activity within laying hens as they are involved in yolk pigmentation and bioaccumulate throughout their bodies, providing their distinctive yellow fat, beaks, shanks, and feet. The proposed research project seeks to investigate the role xanthophyll carotenoids play in the physiological response of laying hens during a heat stress event. Furthermore, this proposal seeks to determine if

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increasing carotenoid intake can be used as a strategy to help mitigate the negative health and production effects of heat stress. Finally, this project seeks to evaluate high carotenoid Orange Corn as an alternative feed ingredient to deliver these potential benefits to laying hens in a commercial alternative housing production system experiencing extreme seasonal weather conditions. Orange Corn is a novel type of corn that has significantly higher xanthophyll carotenoid levels when compared to yellow corn. Furthermore, the carotenoids in Orange Corn appear to be more bioavailable than commercially available carotenoid supplements, making it an attractive alternative for delivering higher levels of carotenoids into the diets of laying hens. This proposal seeks to test the hypothesis that Orange Corn will be able to deliver more carotenoids into the blood and tissues of laying hens and thus increase their total antioxidant capacity. It is hypothesized that this, in turn, will reduce oxidative stress, helping to stabilize laying hen health and performance during a heat stress event. This project will make a meaningful contribution to poultry science and the laying hen industry for a number of reasons: (1) There is a need for more investigation into the effects of heat stress on laying hens, as the majority of work has been conducted on broilers; (2) There is a need for investigation into how heat stress affects laying hens across their lifetime; (3) There have been no previous investigations into the role of xanthophyll carotenoids in the laying hen's response to heat stress; and (4) If successful, this project would offer the laying hen industry a practical nutritional approach for addressing heat stress that also enhances yolk pigmentation and the nutritional quality of the table egg, one of America's most important sources of protein.

Animal Health Component

Animal Health Component: 100%

Research Effort Categories

Basic	60%
Applied	40%
Developmental	0%

Classification

Knowledge Area (KA)	Subject of Investigation (SOI)	Field of Science (FOS)	Percent
315	3210	1010	34%
306	3210	1060	33%
302	3210	1020	33%

Knowledge Area

- [315] Animal Welfare/Well-Being and Protection
- [306] Environmental Stress in Animals
- [302] Nutrient Utilization in Animals

Subject Of Investigation

- [3210] Egg-type chicken, live animal

Field Of Science

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[1010] Nutrition and metabolism

[1060] Biology (whole systems)

[1020] Physiology

Keywords

animal health, carotenoids, chicken, corn, eggs, heat stress, laying hens, nutrition, poultry

Goals / Objectives

The goals for this project include (1) assessing the ability of antioxidant xanthophyll carotenoids to mitigate the negative health effects of heat stress and associated losses in laying hen productivity and (2) assessing high carotenoid Orange Corn as an alternative feed ingredient to deliver these potential benefits to commercial cage-free laying hens. These goals will be pursued through two Technical Objectives. Technical Objective 1: Assess the Ability of Carotenoids to Modulate the Response of Laying Hens to a Heat Stress Challenge in a Controlled Experimental Environment. Technical Objective 2: Assess the Ability of High Carotenoid Orange Corn to Mitigate Production Losses for Commercial Laying Hens Experiencing Extreme Seasonal Weather Conditions.

Project Methods

Two key activities are planned to achieve Technical Objective 1. Key Activity 1 will evaluate the effects of carotenoid intake on carotenoid concentrations, oxidative stress and gut Integrity in birds challenged by heat stress in a controlled experimental environment. The success of this key activity will be measured through five Key Metrics: (1.1) Carotenoid concentrations in the blood, liver, gut and fat pad; (1.2) Total Antioxidant Capacity (TAC) in the blood; (1.3) Markers of oxidative stress in the liver and gut; (1.4) Acid-base balance in the blood; (1.5) Gut histology. Key Activity 2 will evaluate the effects of carotenoid intake on changes in egg characteristics and production Induced by a heat stress challenge in a controlled experimental environment. The success of this key activity will be measured through five Key Metrics: (2.1) Egg quantity; (2.2) Egg size; (2.3) Egg quality; (2.4) Egg yolk color; (2.5) Egg yolk carotenoid content. Two key activities are planned to achieve Technical Objective 2. Key Activity 3 will evaluate the impact of Orange Corn on laying hen productivity throughout their life and during heat stress events in a commercial cage-free production environment. The success of this activity will be measured using the same Key Metrics as Key Activity 2. Key Activity 4 will evaluate the impact of Orange Corn on laying hen health throughout their life and during heat stress events in a commercial cage-free production environment. The success of this activity will be measured using the same key metrics as Key Activity 1.