

**Agriculture Research Foundation**

**Final Report on ARF 8215A award  
Funding Cycle 2013-2015**

**Title: Controlling Oxidative Stress to Enhance Hatchability and Chick Quality**

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**Summary:** Compared to other mammalian species, avian embryo develops inside the egg. Considering the present day market age of 39-42 days, developing chick embryo spends over 33-35% of its total life span inside the egg in the incubator. During the 21-day incubational period, chick embryo utilizes egg yolk lipid as the major source of energy for growth and development. Incubator temperature that is currently used (37.5<sup>0</sup>C) may promote oxidative stress and lipid peroxidation in the fast-growing broiler chick embryo with a high metabolic rate. The increase in oxidative stress may promote lipid peroxidation and may compromise antioxidant status of the embryo and hatchling. The present study investigated the effect of lowering the incubation temperature on tissue lipids, oxidative stress, antioxidant status, and fatty acid profile of day old broiler chicks. Our results revealed that temperature manipulation during incubation affects relative body weight, oxidative stress, antioxidant status and fatty acid metabolism in broiler chicks. In addition we observed embryonic age can affect fatty acid incorporation into the yolk sac membrane of the developing chick. Considering the diverse roles of egg lipids for thermogenesis and membrane biogenesis, investigating the impact of thermal manipulation on lipid metabolism will enable us to develop strategies to enhance growth and viability of the developing chick embryo.

**Objectives:** Modern strains of broiler birds are selected for fast growth and are marketed at 39-42 days after a 21-day incubational period. Heat production of embryos of modern high-yield chicken strains is 44% higher than that reported for embryos in the 1930s. Consequently, there is an over 3-5<sup>0</sup>C increase in incubator temperature, particularly in the latter half of incubation. Incubator temperature that is currently used (37.5<sup>0</sup>C) may promote oxidative stress and lipid peroxidation in the fast-growing broiler chick embryo with a high metabolic rate. The increase in oxidative stress may promote lipid peroxidation and may compromise antioxidant status of the embryo and hatchling. Our working hypothesis is that reducing the incubation temperature will minimize lipid peroxidation, enhance tissue antioxidant status, and increase the retention of long chain PUFA in the embryo and hatched chick. We investigated the effect of incubation temperature on antioxidant and polyunsaturated fatty acid status in the embryo and newly hatched chick.

**Procedures:** Experiments were conducted with broiler hatching eggs kept under different temperature regimes during incubation. Embryonic tissue samples were retrieved to assess antioxidant and fatty acid status, fatty acid binding protein expression in the yolk sac membrane. The hatched chick quality was assessed.

**Significant Accomplishments:** Our results revealed that incubation temperature currently used promotes essential fatty acid retention in the residual yolk sac. Considering the diverse roles of yolk sac and embryo lipids and essential fatty acids for thermogenesis and membrane biogenesis, investigating the impact of thermal manipulation on embryo lipid metabolism will enable us to develop strategies to enhance growth and viability of the developing chick embryo. The results from our studies were presented at annual meetings, submitted as abstracts or are published as conference proceedings or peer-reviewed publications. Additional manuscripts relate to this research are also in the preparation. Details of our presentations or publications are shown below.

## **Scholarship**

### Publications, Presentations and other Scholarly Activities related to this Project

#### **A. Peer-reviewed journal articles**

1. Yigit, A.A., A.K. Panda, and **G. Cherian**. 2014. Avian embryo and antioxidant defense. *World poultry Sci.* 70:563-574.
2. Panda, A.K., and **G. Cherian**. 2014. Role of vitamin E in counteracting oxidative stress in poultry. *Jap. J. Poultry Sci.* 51:109-114.

#### **B. Conference Proceedings**

3. Panda, A. K. and **Cherian, G.** 2014. Effect of thermal manipulation during incubation on oxidative stress, antioxidant status, and fatty acid profile of day old broiler chicks. NGE-1, Proceedings of Global Animal Nutrition Conference, Bangalore India. pp. 189.

#### **C. Published Abstracts**

4. Neumann, P., F.Vercese, **G. Cherian**, M. Kutzler. 2014. Fatty acid composition of the yolk sac membrane in the chick embryo. *Clinical Theriogenology.* 6:369.
5. Neumann, P., F. Vercese, M. Kutzler and **G. Cherian**. 2014. Differential incorporation of fatty acids in the yolk sac membrane during avian embryogenesis. *Poult Sci.* 93 (E-Suppl. 1). Pg. 29. # 84.
6. Neumann, P., M. Kutzler, and **G. Cherian** Immunohistochemical characterization of the expression of fatty acid binding protein 1 in the yolk sac membrane of the developing chick embryo. *Poult Sci.* 93 (E-Suppl. 1). P161. 476P.
7. Vercese, F., and **G. Cherian**. 2014. Incubation temperature influences residual yolk sac lipid uptake by chicken embryos. *Poult Sci.* 93 (E-Suppl. 1). Pg. 96. # 284P.

8. Panda, A.K., and **G. Cherian**. 2013. Effect of incubation temperature on body weight, oxidative stress, antioxidant status, and fatty acid profile of day old broiler chicks. *Poult Sci.* 92 (E-Suppl.1). 1. Pg.96. p# 269.
9. Gullaba, J. M., N.G. Causso, R.S. Oliveira, M. A. Kutzler, and **G. Cherian**. 2013. Isolation and culture of chicken yolk sac membrane cells. *Poultry Sci.* 92 (E-Suppl. 1). Pg. 156. # p 460.

**D. Oral/Poster Presentations**

(\* indicates presenter)

10. Neumann, P\*., F.Vercese, **G. Cherian**, M. Kutzler. Fatty acid composition of the yolk sac membrane in the chick embryo. *Clinical Theriogenology.* 6:369. presented at the. Society of Theriogenology Annual Conference, Portland, Oregon, September 2014. (\*oral presenter).
11. Neumann, P\*. F.Vercese, M. Kutzler and **G. Cherian**. 2014. Differential incorporation of fatty acids in the yolk sac membrane during avian embryogenesis. presented at the 2014 Poultry Science Association annual meeting, Corpus Christie, TX. July 25-30 (\*oral presenter).
12. Vercese, F\*., and **G. Cherian**. Incubation temperature influences residual yolk sac lipid uptake by chicken embryos. presented at the 2014 Poultry Science Association annual meeting, Corpus Christie, TX. July 25-30 (\*poster presenter).
13. Neumann, P\*., M. Kutzler, and **G. Cherian**. Immunohistochemical characterization of the expression of fatty acid binding protein 1 in the yolk sac membrane of the developing chick embryo. presented at the 2014 Poultry Science Association annual meeting, Corpus Christie, TX. July 25-30 (\*poster presenter).
14. Panda, A. K\*., and **Cherian, G.** 2014. Effect of thermal manipulation during incubation on oxidative stress, antioxidant status, and fatty acid profile of day old broiler chicks. Presented at the Global Animal Nutrition Conference, April 20-22, 2014, Bangalore India. (oral presenter).
15. Panda, A. K\*., and **G. Cherian**. Effect of incubation temperature on body weight, oxidative stress, antioxidant status, and fatty acid profile of day old broiler chicks. Poster presented at the 2013 Poultry Science Association annual meeting, San Diego, CA. July 25-30. (\*poster presenter).
16. J. M. Gullaba., N.G. Causso, R.S. Oliveira, M. A. Kutzler, and **G. Cherian**.\* Isolation and culture of chicken yolk sac membrane cells. Poster presented at the 2013 Poultry Science Association annual meeting, San Diego, CA. July 25-30. (\*poster presenter).

**Benefits and Impacts:** Our results revealed that temperature manipulation during incubation affects relative body weight, oxidative stress, antioxidant status and fatty acid metabolism in broiler chicks. In addition we observed that embryonic age can affect fatty acid incorporation into the yolk sac membrane of the developing chick. Considering the diverse roles of egg lipids and fatty acids for thermogenesis and membrane biogenesis, investigating the impact of thermal manipulation on lipid metabolism will enable us to develop strategies to enhance growth and viability of the developing chick embryo.

We were successful in providing training to a diverse group of students or scientists through this project. These include: 2 undergraduate OSU animal sciences students (P. Newman, B.S. Honors part of thesis project, Andrew Beachy, senior capstone project), 1 international PhD student from Brazil (F. Vercese) and 1 postdoctoral fellows (Dr. A.K. Panda from India) through this project.

Persia Newman was the recipient of “Student Certificate of Excellence” at the 2014 Poultry Science Association annual meeting in Corpus Christi, TX. The result obtained from this project is a part of B.S. (Hons). thesis of P. Neumann. She hopes to defend in Spring 2014.

Andrew Beachy completed senior capstone project and is continuing DVM studies at OSU.

**Additional Funding Received:** Francine Vercese was successful in obtaining further funding from Brazil to continue research in this topic under my supervision and will be joining my lab as a post-doctoral fellow in March 2015 for 1 year.

With the preliminary results obtained through the ARF funding, the PI hopes to submit a proposal to U.S poultry on fine tuning embryonic metabolism to enhance hatchability for **future funding**.

On behalf of all the students and other investigators, I wish to express my sincere thanks to ARF for the continued support of my research.