BARD

FINAL REPORT

PROJECT NO. IS-3093-99

**Enhancement of Meat Production by Monochromatic
Light Stimuli during Embryogenesis: Effect on Muscle
Development and Post-Hatch Growth**

O. Halevy, Z. Yablonka-Reuveni, I. Rozenboim

2004

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Project Title: Enhancement of meat production by monochromatic light stimuli during embryogenesis: effect on muscle development and post-hatch growth

Investigators

Principal Investigator (PI): Orna Halevy

**Co-Principal Investigator (Co-PI): Zipora
Yablonka-Reuveni**

Collaborating Investigators: Israel Rozenboim

Institutions

**The Hebrew University
of Jerusalem**

University of Washington

**The Hebrew University
of Jerusalem**

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Keywords Skeletal Muscle, Satellite Cells, Broilers, Embryo, Development

Abbreviations commonly used in the report, in alphabetical order:

Budget: IS: \$167,000

US: \$151,000

Total: \$318,000

Signature
Principal Investigator

Signature
Authorizing Official, Principal Institution

Dr. Eran Vardi, Director
Authority for Research and Development
The Hebrew University of Jerusalem

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Publication Summary (numbers)

	Joint IS/US authorship	US Authors only	Israeli Authors only	Total
Refereed (published, in press, accepted) BARD support acknowledged	1	1	1	3
Submitted, in review, in preparation	1			
Invited review papers				
Book chapters				
Books				
Master theses			1	1
Ph.D. theses				
Abstracts	1		1	2
Not refereed (proceedings, reports, etc.)				

Postdoctoral Training: List the names and social security/identity numbers of all postdocs who received more than 50% of their funding by the grant.

Cooperation Summary (numbers)

	From US to Israel	From Israel to US	Together, elsewhere	Total
Short Visits & Meetings	1	1	1	3
Longer Visits (Sabbaticals)				

Description Cooperation:

Our collaboration led us to investigate the effects of in-ovo green light illumination on skeletal muscle growth. The American team has developed tools to analyze these effects on the molecular basis, which were later used by the Israeli team. In addition, while the Israeli team focused on early cellular and molecular events in muscle development, the American team has studied the later events regarding muscle hypertrophy. Both teams have set a collaboration aimed at studying the basic mechanism of posthatch muscle development. This fruitful collaboration will certainly aid us in future studies on aspects of posthatch muscle development regarding both agricultural issues as well as basic biology.

Patent Summary (numbers)

	Israeli inventor only	US inventor only	Joint IS/US inventors	Total
Submitted				
Issued (allowed)				

ABSTRACT

The original objectives were:

- A. To determine the critical embryonic age for monochromatic green light stimulation.
- B. To follow the ontogeny of embryos exposed to monochromatic green light vs. darkness.
- C. To investigate the effects of monochromatic green light illumination on myoblast and fiber development in the embryo.
- D. To investigate the stimulatory effect of light combinations during embryo and post-hatch periods on growth and meat production.
- E. To evaluate the direct effect of monochromatic green light on cultured embryonic and adult myoblasts.

The overall purpose of this study was to investigate the effect of monochromatic light stimuli during incubation period of broilers on muscle development and satellite cell myogenesis. Based on previous studies (Halevy et al., 1998; Rozenboim et al., 1999) that demonstrated the positive effects of green-light illumination on body and muscle growth, we hypothesized that monochromatic light illumination accelerates embryo and muscle development and subsequently enhances muscle growth and meat production. Thus, further decreases management costs.

Under the cooperation of the laboratories at the Hebrew University of Jerusalem and University of Washington we have conducted the following:

1. We have established the critical stage for exposure to green monochromatic light which has the maximal effect on body and muscle growth (Objective A). We report that embryonic day 5 is optimal for starting illumination. The optimal regime of lighting that will eliminate possible heat effects was evaluated by monitoring egg core temperature at various illumination periods. We found that intermitted lighting (15 min. on; 15 min. off) is optimal to avoid heat effects.
2. We have evaluated in detail gross changes in embryo development profile associated to green light stimuli vs. darkness. In addition, we have investigated the stimulatory effect of light combinations during embryo and post-hatch periods on body and muscle growth (Objective B, D).
3. We have studied the expression profile of muscle regulatory proteins during chicken muscle cell differentiation in cultures using newly developed antibodies. This study paved the way for analyzing the expression of these proteins in our photostimulation experiments (Objective C).
4. We have studied the pattern of Pax7 expression during myogenesis in the posthatch chicken. Experimental chick pectoralis muscles as well adult myoblast cultures were used in this study and the results led us to propose a novel model for satellite cell differentiation and renewal.
5. The effects of monochromatic green light illumination during embryogenesis have been studied. These studies focused on fetal myoblast and satellite cell proliferation and differentiation at pre- and posthatch periods and on the effects on the expression of muscle regulatory proteins which are involved in these processes. In addition, we have analyzed the effect of photostimulation in the embryo on myofiber development at early posthatch (Objective C).
6. In follow the reviewers' comments we have not conducted Objective E.

The information gathered from these studies is of utmost importance both, for understanding the molecular basis of muscle development in the posthatch chicks and for applied approach for future broiler management. Therefore, the information could be beneficial to agriculture in the short term on the one hand and to future studies on chick muscle development in the embryo and posthatch on the other hand.

ACHIEVEMENTS

Our primary hypothesis was that in-ovo monochromatic light illumination accelerates embryo and muscle development and subsequently enhances muscle growth and meat production, thus further decreases management costs.

Our Israeli and American groups have proved that this hypothesis is valid, therefore should have a short term impact on the agricultural industry.

In detail, in this project we have accomplished major achievements both from the agricultural and basic biology points of view:

1. We have established the critical stage for exposure to green monochromatic light that has the maximal effect on embryo development and post-hatch growth (Israeli group, publication 1).
2. We determined the optimal regime for illumination in order to minimize heat effects on embryonic development (Israeli group, publication 1). This is the first study that had undertaken the side effects of heat which mask the net effect of lighting on the growth and development of embryos and posthatch broilers.
3. Our studies on various combinations of lighting schedule in-ovo and posthatch have set the optimal regime which will lead to the best performance of broilers (i.e., body weight and meat production) (Israeli group, publication 1).
4. Numerous studies have shown the effect of in-ovo illumination on avian development however, this is the first study that followed in detail the ontogeny of the developing broiler embryos (Israeli group, publication 1).
5. During this study we have developed valuable tools to study the effect of lighting on muscle development (American group, publication 2). We have validated the optimal antibodies and conditions to address the molecular and cellular basis for muscle development in response to in-ovo illumination.
6. We present at least in part the mechanism by which in-ovo green light illumination affects skeletal muscle growth. We show its promoting effects on satellite cell proliferation and myogenesis during embryogenesis and at early posthatch. In addition, employing morphometric approach for the analysis of posthatch myofiber growth, we

show the positive effect of in-ovo illumination on fiber formation at posthatch (American and Israeli groups, publication 3).

7. Our collaboration led us to investigate the pattern of molecular events during myogenesis of satellite cells posthatch. Our findings led us to suggest that during early stages of posthatch growth, while some of the myoblasts differentiate and fuse into myofibers, others retain their reserve cell capacity (American and Israeli groups, publication 4).

List of publications:

1. Rozenboim I., Piestun, Y., Mubarki, N., Hoizman, A., Barak, M. and Halevy O. (2004) Monochromatic light stimuli during embryogenesis enhances embryo development and posthatch growth. Poult. Sci. In press.
2. Yablonka-Reuveni, Z. and Paterson, B. (2001) MyoD and myogenin expression patterns in cultures of fetal and adult chicken myoblasts. J. Histochem. Cytochem. 49: 455-462.
3. Halevy, O., Piestun, Y., Rozenboim, I., and Yablonka-Reuveni, Z. (2004) In-ovo exposure to monochromatic green light promotes skeletal muscle cell proliferation and synchronizes myofiber development in posthatch chicks. Submitted.
4. Halevy, O., Piestun, Y., Allouh, M.Z., Rosser, B., Rinkevitch, Y., Reshef, R., Rozenboim, I., Wleklinski, M., Yablonka-Reuveni, Z. (2004) The pattern of Pax7 expression during myogenesis in the posthatch chicken establishes a model for satellite cell differentiation and renewal. Dev. Dyn. Accepted for publication.