Hot Weather Management and Minimizing Wet Litter Problems of Poultry

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Feed Production of Southeast Asia

Thailand: 17.92 Million Tons
Vietnam: 14.75 Million Tons
Philippines: 12.78 Million Tons
Myanmar: 1.00 Million Tons
Malaysia: 4.35 Feed/Capita
Indonesia: 17.33 Million Tons

Alltech Global Feed Summary
Complete Feed Production (Thailand)

Poultry take an account 59% of feed production.
Broiler Density Map: Thailand

- Broiler Hub
  - Saraburi
  - Lopburi
  - Nakhon Ratchasima

- Grain production area - Corn
- Laem Chabang Port

<table>
<thead>
<tr>
<th>Area</th>
<th>Non Integrated</th>
<th>Integrated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Birds</td>
<td>140,140,000</td>
<td>1,261,260,000</td>
</tr>
</tbody>
</table>

- Non Integrated 10%
- Integrated 90%

http://ict.dld.go.th

The Market Information 2015,
Animal Health Products Association
Broiler Meat & Market share

Source: Thai Broiler Processing Exporters Association
Chiang Mai population: 1.6 million

Bangkok population: 6.5 million

Layer Hub (100 km from Bangkok)
- Chachoengsao
- Chonburi

Layer Density Map: Thailand

- Integrated, 20%
- Non-integrated, 80%

The Market Information 2013,
Animal Health Products Association
**AVG. Egg Prices, Year 2010-2014 (baht/100 egg)**

- **Summer school vacation**
- **Low demand**
- **Low supply**
- **High Temperature in Summer**
- **Disease Outbreak**
- **Beginning summer**

**High rates of return on investment**

- **EVAP?**
- **Increase feed quality**
- **Use of feed additive as growth promoters**
- **Increase production rate**

**Average Cost = 264**

Thai Feed Mill Association – Thailand
- The **catabolism** during heat stressed certainly induces the negative energy balance

- Avoid eating before maximum heat load
- Supply clean water *Ad libitum*
- **Micro-nutrients supplement in drinking water**
Big temperature gaps between day and night
### Broiler trial: Opened House Operation, KU Research Farm

#### Mortality

<table>
<thead>
<tr>
<th>Age (d)</th>
<th>Starter (0 – 10 days)</th>
<th>Grower (11 – 24 days)</th>
<th>Finisher I (25 – 31 days)</th>
<th>Finisher I (32– 38 days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-10</td>
<td>0.26 %</td>
<td>1.83 %</td>
<td>1.65 %</td>
<td>21.57 %</td>
</tr>
<tr>
<td>1-31</td>
<td>1-31 days</td>
<td>3.65 %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-38</td>
<td>1-38 days</td>
<td>23.78 %</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Body Weight
- **Average Body Weight, 1997.20 g**
- **Average Body Weight, 2491.69 g**

#### Death from heat

- KU Research Farm
Layer Trial: Opened and EVAP, KU Research Farm

Egg production (%)

- Open House = 71.45%
- EVAP = 76.69%
- 6.87%
Layer Trial: Opened and EVAP, KU Research Farm

Mortality (%)

- 21-28 wk: 3.96%
- 29-36 wk: 5.65%
- 37-44 wk: 5.45%

- Open House: 14.38%

KU Research Farm

- Open: 9.97%
- EVAP: 4.59%
Performance of Laying Hens VS. Standard in Commercial Farm

- Prolong egg production
- High feed intake
- Bad FCR egg

Non-peak production period
Open House (°C)  EVAP (°C)

- Highest temperature (HT)
- Lowest temperature (LT)
- Average temperature (AVG)

- Open House: 29.06, 31.95, 34.6
- EVAP: 23.59, 25.82, 28.2

KU Research Farm
Feed (Feedstuffs)

- **Energy Source**
  - Carbohydrate, Fat and Protein

- **Protein Source**

- Nutritive Feed Additives

- Non-nutritive Feed Additives

Requirements

- **Energy**
- **Protein** + Energy

Quality

Growth Performance

- **Optimal Profitability**
- Return on Investment (ROI)
What is Homeostasis?
Understanding Body Regulation

Warm-blooded Animals (Homeotherms)

- Adult chicken the variability is between 40.6° and 41.7°C
- Newly hatched chick is about 39.7°C
Heat Production

How do birds produce heat?

- **Metabolic Heat Production**
  - Anabolism (Modern Genetic***)
  - Catabolism
    * Protein* > Carbohydrate > Fat*
- **Gut Fermentation (NSP)**
- High ambient temperature increases metabolic heat production

Heat Loss

How do birds lose heat?

- **Radiation**
  - Depends on the surface temperature
  - Body surface area/body weight
- **Convection**
  - Wind chill effect (Fan speed)*
- **Conduction** (limit)
- **Evaporation**
  - Panting (loss energy – Metabolic Disorder (Eggshell quality))
  - Evaporative cooling operation*

Temperature range: 40.6 - 41.7°C

* Energy load (Electrical load)
Heat Production

Heat Loss

Early hatched – Young chicks

Heat Brooding

Metabolic Heat Production

Heat Production

40.6 - 41.7°C

High - Body surface area / Body weight

Heat Brooding
Mature chicks

Metabolic Heat Production
- Modern Genetic
- Faster growth rate or egg productivity
- Higher growth potential

Heat Production

High Ambient temperature

40.6 - 41.7°C

Evaporative Cooling System

How do birds respond?
- Reduce heat production
- Reduce feed intake
- Growth rate or egg production will reduce

Low - Body surface area / Body weight
Panting: Respiratory Alkalosis

- Requiring energy use that generates some additional heat.
- Increased respiration rate results in loss of carbon dioxide.
- High relative humidity reduces the effectiveness of evaporative heat loss.

\[
\text{Loss CO}_2: \quad \text{H}_2\text{O} + \text{CO}_2 \rightarrow \text{HCO}_3^- + \text{H}^+ 
\]

Shell formation:
\[
\text{Ca} + \text{HCO}_3^- \rightarrow \text{CaCO}_3
\]

Feed and Bone:

Acid-Base Balance:

Egg shell formation:

Soft-shelled egg and crack shell.
Impact of heat stress on egg quality in layer hens

Decrease evaporative heat loss - Ventilation

Bicarbonate – Sodium Bicarbonate Supplementation

H₂O + CO₂

Zinc ion

Carbonic anhydrase

HCO₃⁻ + H⁺

Ca + HCO₃⁻ → CaCO₃ (Egg shell)

Antagonism

Feed

Give an extra Ca? – Limestone, Oyster shell

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Ventilation

Bicarbonate –

Sodium Bicarbonate Supplementation

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++++

++++

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Feed and Drinking Water

- In practice, drinking water is continuously supplied.

- In term of consumptions, ratio of water : feed consumption is around 1.8-2.2 : 1.

- Animal response to heat stress by decreasing feed intake and increasing water consumption.

- Hence, supplemental some micronutrients into drinking water is an effective and powerful strategy to maintain production performance and health status during unusual conditions.
Maximum Heat Load Management

- Dietary carbohydrates are the body's main source of energy.

- During feed starvation, glycogen and fat reserves can maintain body functions as energy sources.

- The catabolism needs vitamins and minerals as co-enzyme and co-factors.

- Thus, supplemental vitamin (B-Complex) into drinking water should be focused.

- In addition, Vitamin C has been demonstrated to enhance antioxidant activity of vitamin E by reducing the tocopheroxy radicals back to their active form of vitamin E.
Vitamins in Drinking Water

One kg of the complete mixture of various vitamins provides the following:

- Vitamin A 2.50 MIU,
- Vitamin D3 1.00 MIU
- **Vitamin E 85 g**
- Vitamin K3 0.80 g
- **Vitamin B1 1.80 g**
- **Vitamin B2 2.50 g**
- **Vitamin B6 1.80 g**
- **Vitamin B12 0.01 g**
- Pantothenic acid 10.00 g
- Niacin 20.00 g
- Folic acid 0.30 g
- Biotin 0.03 g
- Vitamin C 40.00 g
- Potassium 2.00 g
- Preservatives 10 g.

The carrier added brings the total to 1.00 kg.

Add 1 g/L of drinking water

Journal of Applied Sciences, 14: 3493-3499.
Micronutrient interactions in the antioxidant defense system

Lipid

Vitamin E Cycle

α-Tocopheroxyl-
α-Tocotrienoxyl-
Radical

Vitamin C Cycle

Lipid/Water Interface

Ascorbate

Waters

ROOH, ROH

ROO•, RO•

PUFA

O2− & other radicals

Pro-Oxidants

UVA, UVB, Ozone

Vit. E is a Fat Soluble Antioxidant
Feed (Feedstuffs)

**Protein Source**
- Soybean Meal
- Full Fat Soybean Meal
- Fish Meal
- Poultry Meal
- Pork Meal
- Extracted Rice Bran
- Rape Seed Meal
- Palm Kernel Meal
- Cottonseed Meal
- Sunflower Meal

**Energy Source**
- Broken Rice
- Cassava
- Corn
- Rice Bran
- whole Wheat
- Sorghum
- Wheat Bran
- Palm Oil
- Rice Bran Oil
- Soybean Oil
- Poultry Fat

**Nutritive Feed Additives**
- DL-Met
- L-Lys
- L-Thr
- L-Try
- DCP
- MDCP
- CaCO3
- Salt
- Premix
- Betaine
- Choline

**Non-Nutritive Feed Additive**
- Enzyme
- Antioxidants
- Organic Acids
- Pre-Probiotic
- Flavors
- Toxin Binder
- Color Pigment
- Cheated Minerals
- Carcass Modifiers
- Odor Control Agents
- Phytochemicals

**Grain : 40-60%**
- Oil : 2-6%
- 10-15 %
- < 1-2%

**Plant : 10-30%**
- Animal : 2-8 %
Chemical Composition of Feedstuffs

- Organic matter
- Protein* and Amino Acids****
  - Fat*
  - Vitamins
  - Carbohydrate
  - Sugar
  - Starch
  - Fiber*
- Inorganic matter (Ash*)
  - Calcium***
  - Phosphorus***
  - Salt***
  - Others
- Moisture*

Energy**
Energy System in Feed

- High Protein Feed
- Imbalance Amino acid Feed

- Decrease CP
- Synthetic Amino acid Supplement
- Increase Fat/Oil

Energy (Kcal/kg)

<table>
<thead>
<tr>
<th>Feces</th>
<th>Urine</th>
<th>Heat Increment</th>
<th>Maintenance</th>
<th>Egg &amp; Tissue</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 %</td>
<td></td>
<td></td>
<td></td>
<td>GE, 4000 Kcal/kg</td>
</tr>
<tr>
<td>20 %</td>
<td>80 %</td>
<td></td>
<td></td>
<td>DE, 3200 Kcal/kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>72.5 %</td>
<td></td>
<td>ME, 2900 Kcal/kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>57.5 %</td>
<td></td>
<td>NE, 2300 Kcal/kg</td>
</tr>
</tbody>
</table>

600 kcal is the metabolic heat

- High Fiber
- Non-Digestible Protein feed
- Phytate Complex

Feed ingredients
Enzyme?
NSP Enzyme (glucanase, cellulase, xylanase and other enzyme) contribute to the hydrolyses of insoluble cell wall carbohydrates and other viscous non-starch polysaccharides (NSP) and results in increase energy utilization.
Fat

Fatty acid + Glycerol

Carbohydrate

Glucose + Glycogen

Niacine, Biotin, Pantothenic acid, Mg²⁺, K⁺

Pyruvate

Niacine, Thiamine, Pantothenic acid

Acetyl-CoA

Energy

Niacine, Riboflavin, Fe²⁺, Fe³⁺, Cu²⁺

TCA cycle

Vitamin B6

Folate, Vitamin B6, Vitamin B12, Niacine, Co

Protein

Vitamin C, Folate, Vitamin B6, Vitamin B12, Niacine, Mn²⁺, Fe²⁺, Se, Ni²⁺, Co

Amino acid

Deamination

Ammonia

Urea/Uric

Fat

Carbohydrate

Protein

Energy
Non Essential Amino acids

Semi-Essential Amino acids

Essential Amino acids

Amino Acid Metabolism

Lysine

Methionine

Threonine

Tryptophan

Cysteine

Arginine

Tyrosine

Phenylalanine

Histidine

Basic amino acids

Arginine

Tyrosine

Phenylalanine

Histidine

Basic amino acids

Lysine

Methionine

Threonine

Tryptophan

Cysteine

Arginine

Tyrosine

Phenylalanine

Histidine

Basic amino acids

Lysine

Methionine

Threonine

Tryptophan

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Cysteine

Arginine

Tyrosine

Phenylalanine

Histidine

Basic amino acids

Lysine

Methionine

Threonine

Tryptophan

Cysteine

Arginine

Tyrosine

Phenylalanine

Histidine

Basic amino acids

Lysine

Methionine

Threonine

Tryptophan

Cysteine

Arginine

Tyrosine

Phenylalanine

Histidine

Basic amino acids

Lysine
Methyl Donor: Methionine, Betaine and Choline

Powder Methionine
- DL-Methionine
- 2-amino-4-(methylthio)butanoic acid
- Amino acids

Liquid Methionine
- LMA or MHA
- Methionine Hydroxy Analog
- 2-hydroxy-4-(methylthio)butanoic acid
- Organic acids

Transamination
- Folic acid
- tetrahydrofolate
- 5,10-methylene tetrahydrofolate
- MTHFR
- 5-methyltetrahydrofolate

Methionine & Cysteine Interaction
- SAM
- Phosphatidyl-ethanolamine
- Phosphatidyl-choline
- VLDL
- Dimethyl-glycine
- BHMT
- Betaine
- Choline
- HOMOCYSTEINE
- Cysteine

✓ Betaine
✓ Choline
Synthetic Amino acids

“Liebig's law of the minimum”

*Balance amino acids save 5% of feed cost!!*

How to increase protein synthesis?

- Using high density amino acids feedstuffs;
  - Fish Meal
  - Pork/Poultry Meal/MBM
- Using high protein feed
- Balance amino acids using synthetic amino acids *

Feed Cost?
The feeding periods were provided as follows:

- **Starter** (1-10 days)
- **Grower** (11-24 days)
- **Finisher I** (25-39 days)
- **Finisher II** (40-47 days)

Corn and soybean meal based diet

Feed was pellet form

All diets satisfy the nutritional requirements described in strain’s manual.
Managements

The evaporative cooling house system was used in this trial

All managements were done according to strain’s recommendation
### Experiment I: Growth performance of broiler at 39 days of age

#### Growth performance

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial body weight (g)</td>
<td>42.66 ± 0.45</td>
</tr>
<tr>
<td>Body weight (g)</td>
<td>2876.08 ± 41.51</td>
</tr>
<tr>
<td>Body weight gain (g/bird)</td>
<td>2833.42 ± 41.47</td>
</tr>
<tr>
<td>Average daily gain (g/bird)</td>
<td>72.65 ± 1.06</td>
</tr>
<tr>
<td>Daily feed intake (g/bird)</td>
<td>107.17 ± 0.84</td>
</tr>
<tr>
<td>Daily Water intake (g/bird)</td>
<td>249.02 ± 3.67</td>
</tr>
<tr>
<td>Water intake/Feed intake</td>
<td>2.32 ± 0.04</td>
</tr>
<tr>
<td>FCR</td>
<td>1.48 ± 0.02</td>
</tr>
<tr>
<td>Mortality</td>
<td>2.08 ± 2.92</td>
</tr>
</tbody>
</table>

39 days Body Weight Objective = 2705 g
## Growth performance

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial body weight (g)</td>
<td>42.66 ± 0.45</td>
</tr>
<tr>
<td>Body weight (g)</td>
<td>3441.28 ± 29.10</td>
</tr>
<tr>
<td>Body weight gain (g/bird)</td>
<td>3398.62 ± 28.89</td>
</tr>
<tr>
<td>Average daily gain (g/bird)</td>
<td>72.31 ± 0.61</td>
</tr>
<tr>
<td>Daily feed intake (g/bird)</td>
<td>118.87 ± 1.18</td>
</tr>
<tr>
<td>Daily Water intake (g/bird)</td>
<td>293.81 ± 5.74</td>
</tr>
<tr>
<td>Water intake/Feed intake</td>
<td>2.47 ± 0.06</td>
</tr>
<tr>
<td>FCR</td>
<td>1.64 ± 0.02</td>
</tr>
<tr>
<td>FCG (Baht/kg)</td>
<td>21.59 ± 0.19</td>
</tr>
<tr>
<td>Mortality</td>
<td>3.75 ± 4.11</td>
</tr>
</tbody>
</table>
Laying hen performance at 37-52 weeks (1\textsuperscript{st}-16\textsuperscript{th} week of trial) of Lohman Brown Classic laying hen
Laying hen performance at 37-52 weeks (1st-16th week of trial) of Lohman Brown Classic laying hen

<table>
<thead>
<tr>
<th>Item</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hen-day egg production (%)</td>
<td>94.63 ± 0.79</td>
</tr>
<tr>
<td>Hen-house egg production (%)</td>
<td>94.00 ± 1.36</td>
</tr>
<tr>
<td>Average feed intake (g/hen/day)</td>
<td>119.98 ± 1.24</td>
</tr>
<tr>
<td>Feed intake/dozen egg (kg)</td>
<td>1.52 ± 0.01</td>
</tr>
<tr>
<td>Feed price/dozen egg (Baht)</td>
<td>15.82 ± 0.11</td>
</tr>
<tr>
<td>Average egg weight (g)</td>
<td>66.15 ± 1.23</td>
</tr>
<tr>
<td>Egg mass (g/hen/day)</td>
<td>62.60 ± 1.07</td>
</tr>
<tr>
<td>FCR</td>
<td>1.94 ± 0.01</td>
</tr>
<tr>
<td>FCR x Feed price (Baht)</td>
<td>20.16 ± 0.14</td>
</tr>
<tr>
<td>Mortality (%)</td>
<td>1.08 ± 0.94</td>
</tr>
</tbody>
</table>
Conclusion

High Ambient Temperature

- Provide adequate ventilation and density in broiler/Layer houses
- Concerning the performance objective or the limitation during the summer period (Big birds produce high heat and bad in heat loss)
- Avoid the heat production during highest day temperature.
  - Avoid eating before the maximum heat load
  - Increase dietary fat/oil
  - Use low protein diet and balance amino acids
  - Supplement micronutrients in drinking water
- Heat stress and egg quality
  - Limits the respiratory alkalosis and give extra bicarbonate