INTERNATIONAL IPPE PRODUCTION & PROCESSING EXPO

LA CUMBRE AVÍCOLA LATINOAMERICANA

Keeping cool: mitigating the impact of heat stress in poultry using phytogenic feed additives

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In collaboration with:

INTERNATIONAL IPE POULTRY EXPO

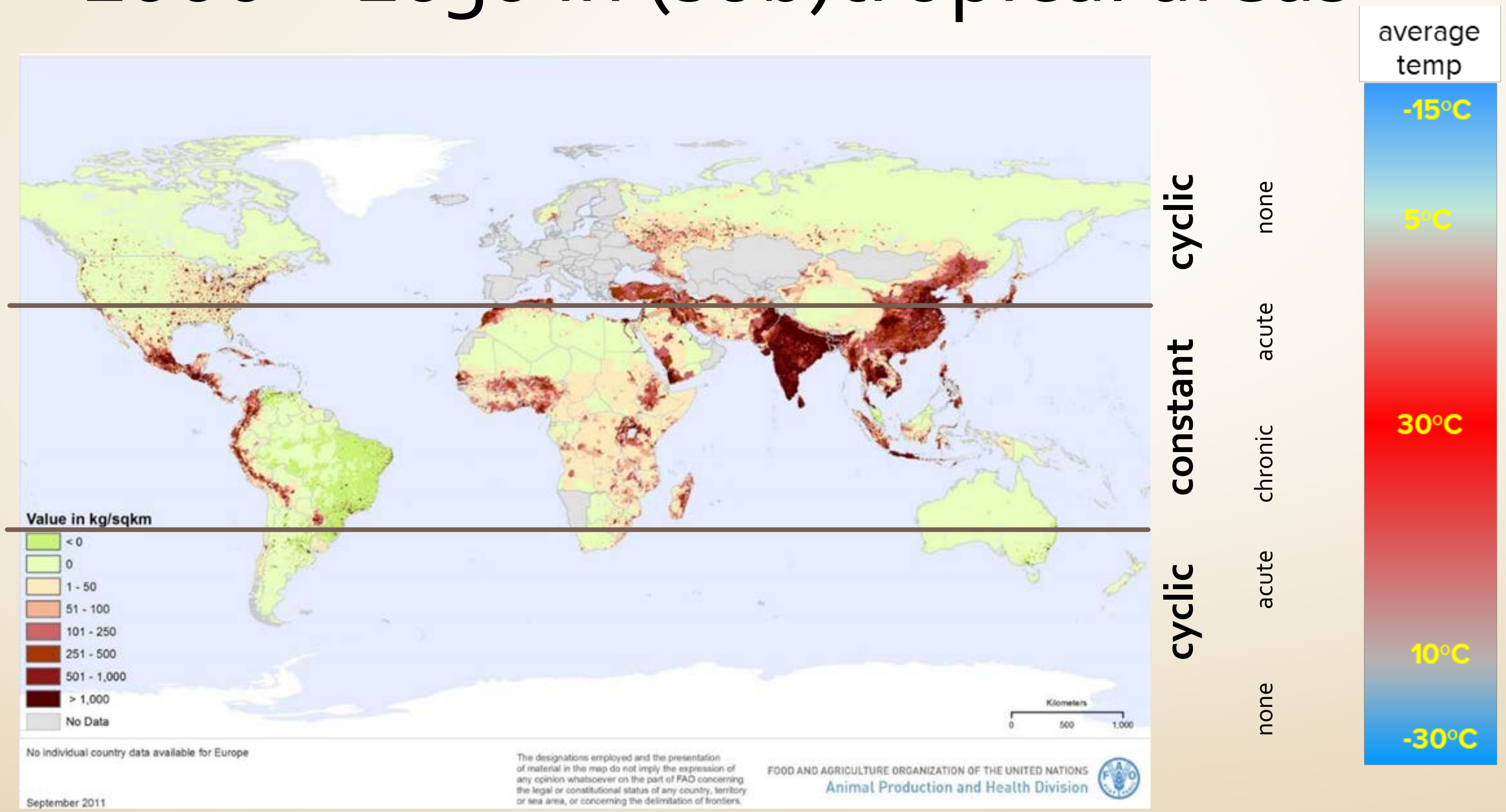
WATT GLOBAL MEDIA

ALA

Introduction

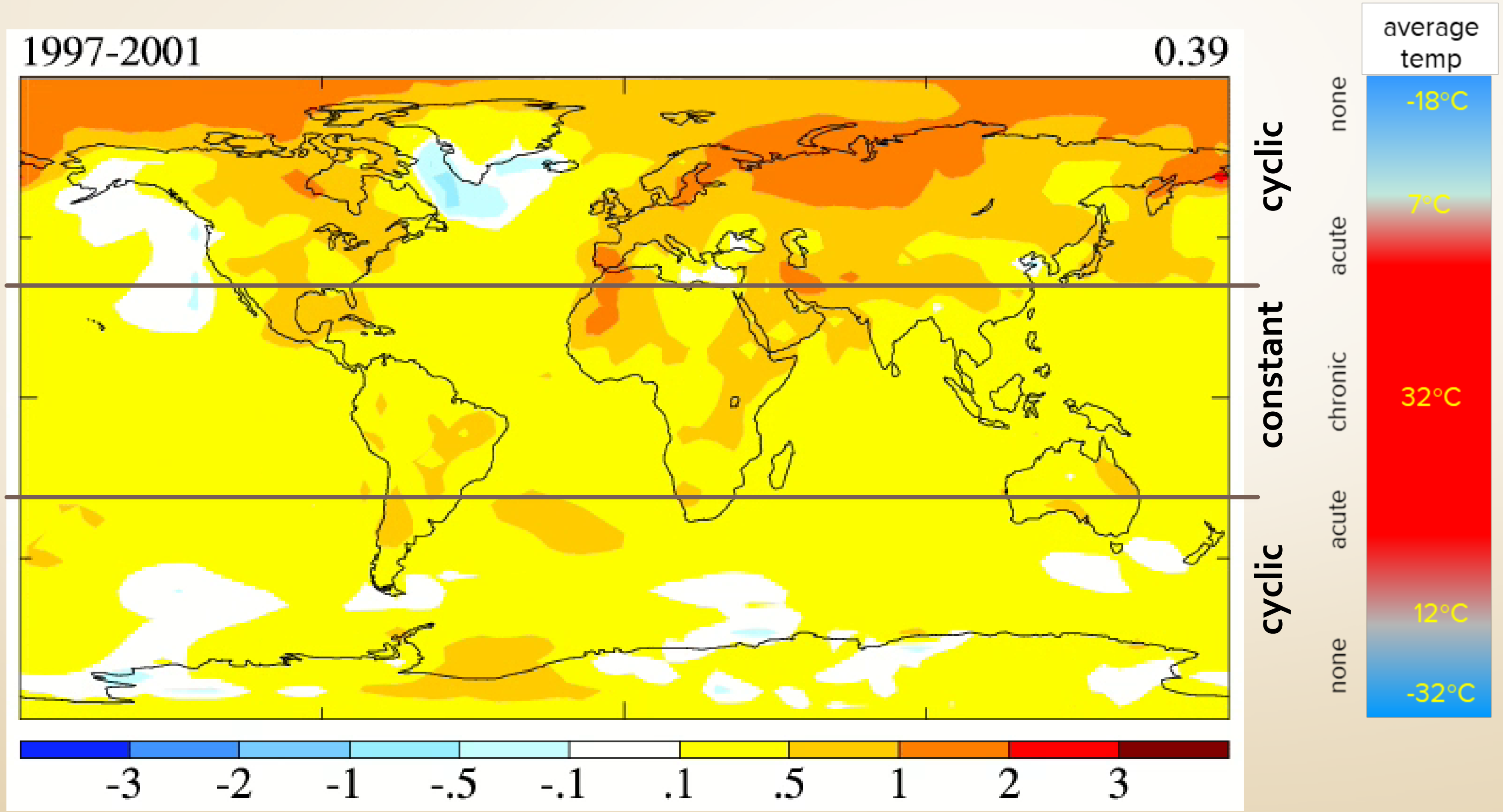
- The impact of heat stress
- Examples of research of phytogenics and heat stress
- Tools for evaluating phytogenic candidates for heat stress management
- Validating those candidates
- Summary

Major growth in demand for poultry meat 2000 – 2030 in (sub)tropical areas



Source: FAO (September 2011)

2000 – 2030: Increasing global temperature



NASA ModelE Climate Simulation (SC07)

Heat stress:
Acute (short duration) and chronic (long-term)
Cyclic (diurnal rhythm) and constant (no diurnal rhythm)

Temperature/Humidity Index (THI) and heat stress

ambient temperature (℃)

relative humidity (%)	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
100	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135
95	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130
90	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
85	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
80	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115
75	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110
70	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
65	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
60	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
55	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
50	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
45	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
40	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75

too hot

115

muggy

95

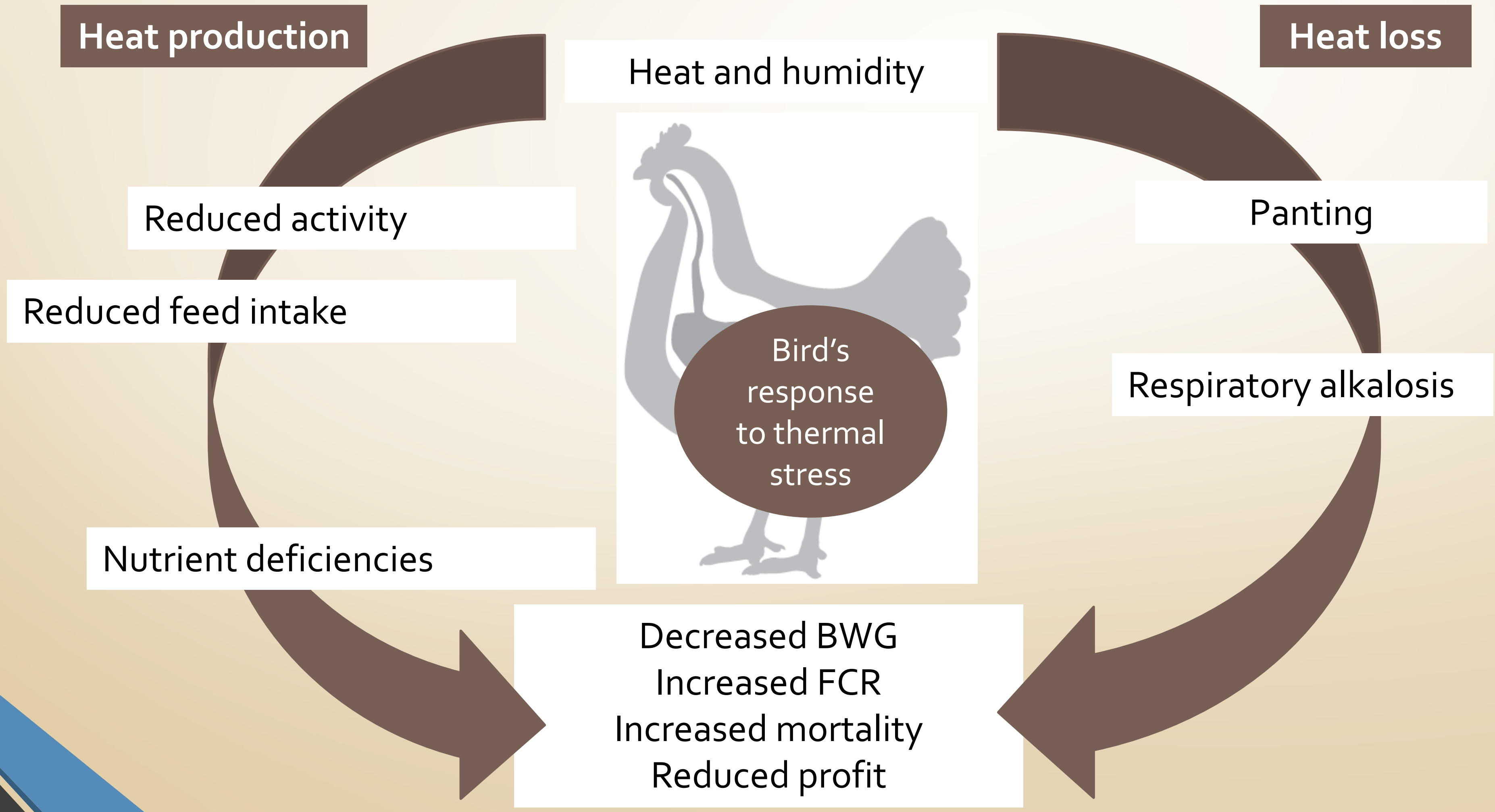
comfortable

85

too cold

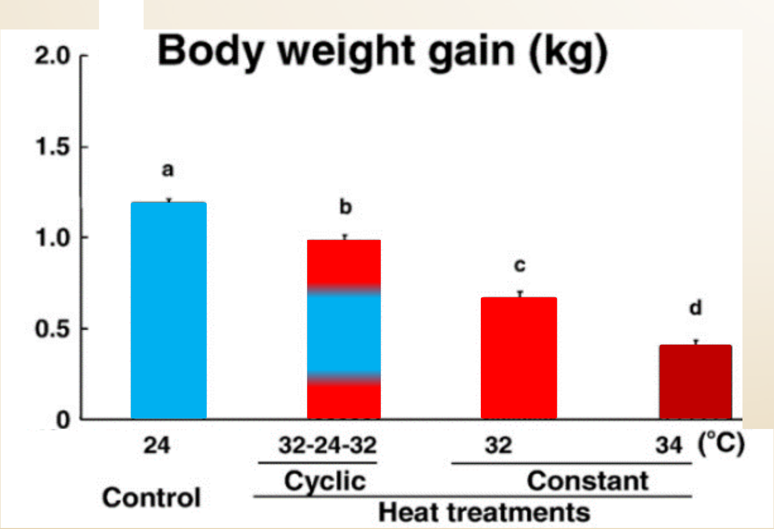
Broiler signals (2015)

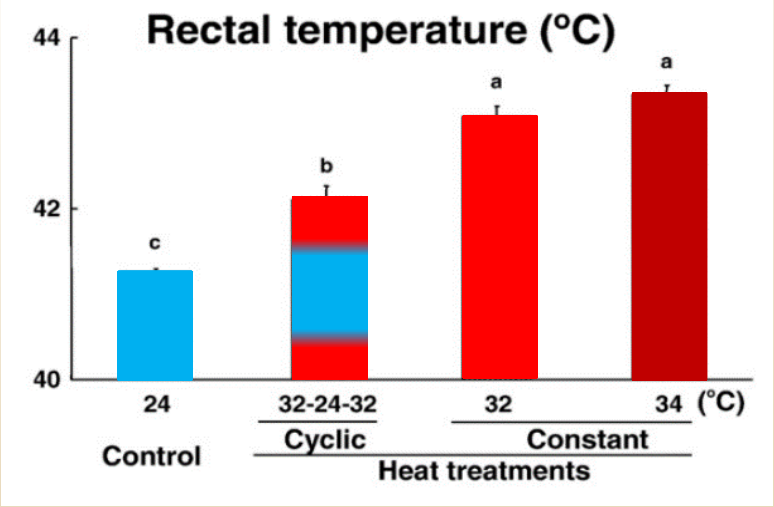
Different mechanisms to restore balance



Effect of heat stress in broilers

- Ross broilers exposed to chronic heat stress day 14-28
- <u>Heat stress:</u>
  - **Cyclic:** 32-24-32°C (32°C for 8h/d)
  - **Constant:** 32 or 34°C

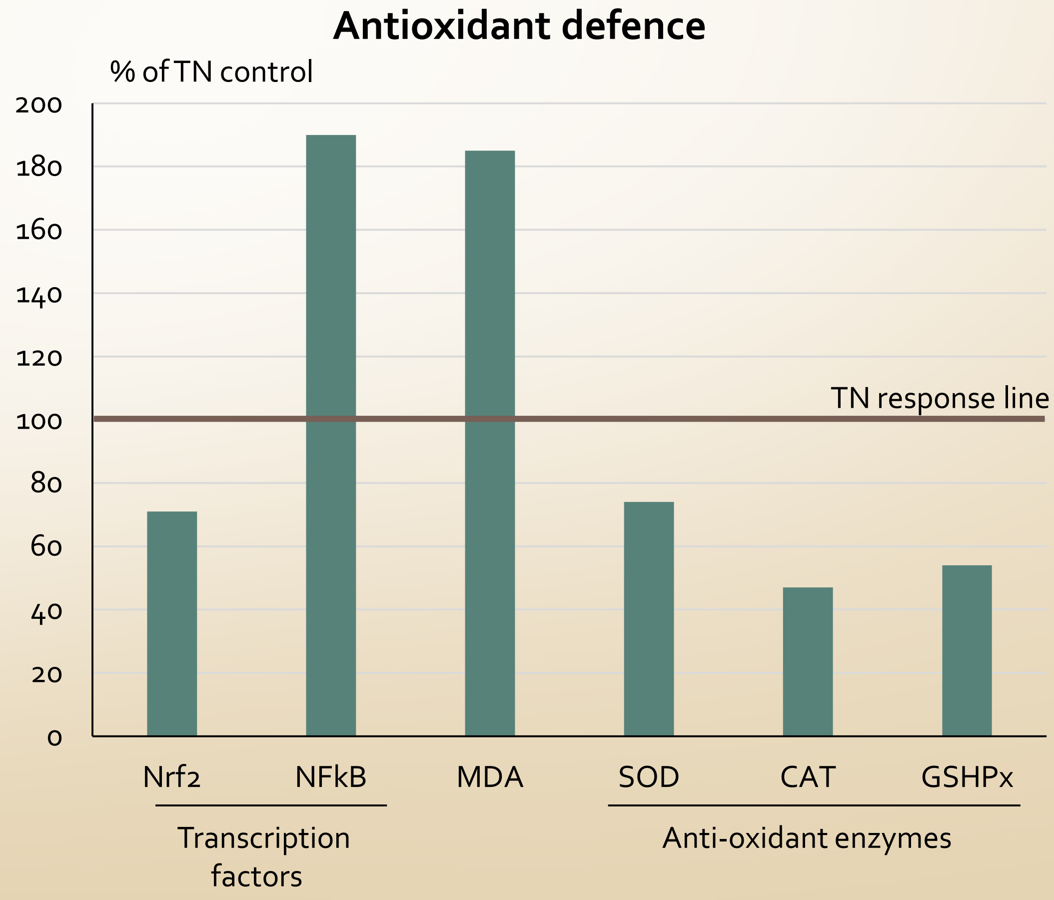




Source: Azad *et al.* (2009)

Heat stress challenges the anti-oxidant defense system

- 180 Quail
- Heat-stress treatments:
  - TN (22ºC)
  - HS (34ºC: 8h/d for 12 wk)
- Oxidative stress biomarkers:
  Hepatic **MDA, SOD, CAT, GSHPx**
  Hepatic transcription factors: **Nrf2 and NFκB**
- **Results:**
  - Feed intake and egg production reduced by 10% and 14%



Source: Sahin *et al*. (2010)

Effect of heat stress in laying hens

A meta-analysis of 131 peer-reviewed papers:

	Thermo-neutral (15-29 °C)	Heat stress (30-35 °C)	Change (%)
Feed intake (g/d)	112.8	87.3	-23
Egg production (%)	86.9	77.1	-11
Egg weight (g)	58.1	53.9	-7
Egg mass (g/b/d)	48.5	44.1	-9
Shell strength (g)	3513	3009	-11
Shell thickness (mm)	0.363	0.344	-5

Mignon-Grasteau *et al.* (2015)

Strategies to reduce the impact of heat stress

Management
Withdraw feed
Adequate feeder space and drinkers
Add salt to water
Cool water
No disturbance of birds during peak of heat
Midnight feed/water
Proper ventilation
Genetics

Formulation
Maintain CP level in feed
Increase synthetic amino acid level in the feed
Energy: Carbohydrates → Fat (but keep same energy level)
High digestible raw materials
Maximize salt level (attention litter moisture)
Electrolyte balance
Pellet quality
Feed additives

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Phytogenic feed additives

The world of plant ingredients

Effect of Rosemary on liver histopathology in Japanese quail

- TN: 22°C for 24 h/d. For heat-stress: 34°C for 8 h/d, 22°C 16 h/d
- Relative humidity was approximately 60–65%

	HS			TN				P- Statistical significance	
	Rosemary oil, mg/kg			Rosemary oil, mg/kg				Main effects	
Lesions	**0**	**125**	**250**	**0**	**125**	**250**	**SEM**	**Environmental conditions**	**Amount of feed additives**
Kupffer cell activation	1.71[a]	0.860[b]	1.71[a]	0.148[B]	0.364[AB]	1.00[A]	0.216	$P < 0.05$	$P < 0.05$
Fatty degeneration	2.45[a]	0.715[c]	2.04[b]	0. 423[B]	0.712[B]	1.57[A]	0.181	$P < 0.05$	$P < 0.05$
Apoptotic body	1.71[a]	0.000[b]	2.14[a]	0.000[B]	0.000[B]	0.861[A]	0.100	$P < 0.05$	$P < 0.05$
Bile pigment accumulation	1.28[a]	0.365[b]	0.862[b]	0.000[B]	0.000[B]	0.713[A]	0.103	$P < 0.05$	$P < 0.05$
Extramedullary hematopoiesis	2.43[a]	1.00[b]	2.43[a]	1.00[B]	1.00[B]	1.57[A]	0.195	$P < 0.05$	$P < 0.05$
Hepatocyte apoptotic index	12.5[b]	7.63[c]	19.1[a]	2.57[B]	3.29[B]	10.7[A]	0.681	$P < 0.05$	$P < 0.05$

Ozcelik et al. (2014)

Effect of Ginger powder on laying rate

Effect of ginger powder, Chinese herbal medicine on production performance of laying hens.

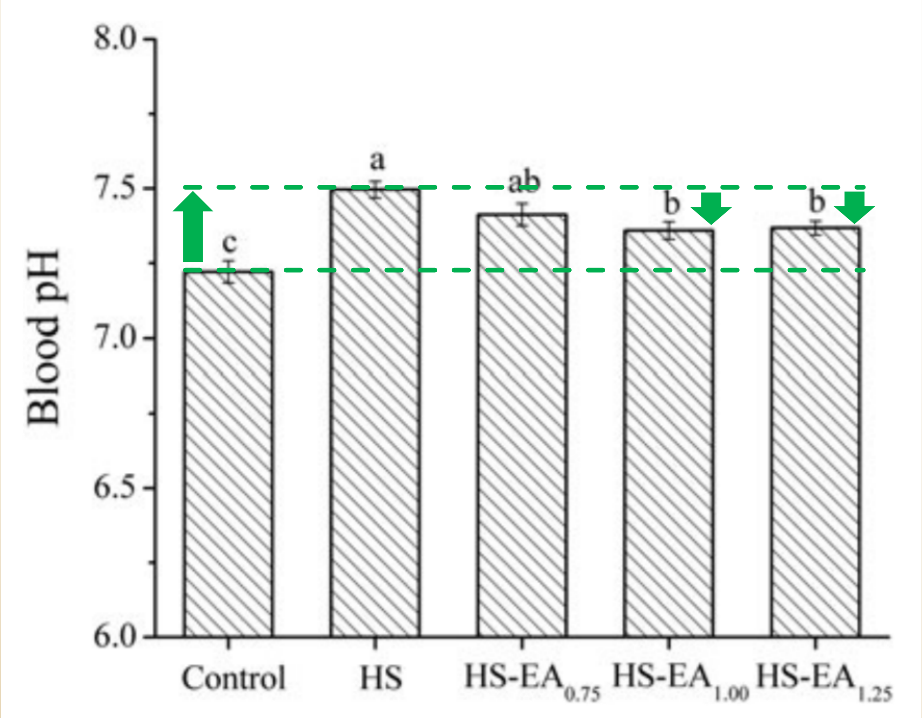
Parameters	Time/ week	NC	HC	H1
Daily feed intake	1–3 w	89.69 ± 6.29^{ab}	83.21 ± 4.00^{a}	85.05 ± 7.09^{a}
	4–6 w	95.41 ± 4.08^{a}	77.35 ± 9.84^{b}	88.74 ± 5.95^{a}
	7–9 w	107.94 ± 3.76^{a}	90.41 ± 3.27^{b}	94.84 ± 2.24^{b}
	1–9 w	97.68 ± 9.08^{b}	83.66 ± 8.15^{d}	89.54 ± 6.63^{c}
Laying rate (%)	1–3 w	75.97 ± 2.24^{a}	66.45 ± 5.95^{b}	69.05 ± 6.84^{b}
	4–6 w	74.35 ± 1.24^{a}	65.73 ± 2.38^{b}	70.63 ± 2.38^{c}
	7–9 w	73.65 ± 9.54^{ac}	65.62 ± 1.75^{b}	70.03 ± 1.78^{ab}
	1–9 w	74.66 ± 5.26^{a}	65.93 ± 3.62^{b}	69.90 ± 4.30^{c}
Feed/Egg	1–3 w	2.44 ± 0.24	2.51 ± 0.37	2.35 ± 0.33
	4–6 w	2.36 ± 0.06	2.27 ± 0.28	2.49 ± 0.58
	7–9 w	2.60 ± 0.28	2.51 ± 0.21	2.51 ± 0.30
	1–9 w	2.38 ± 0.26^{ab}	2.43 ± 0.30^{ab}	2.45 ± 0.41^{ab}
Average egg weight (g)	1–3 w	54.66 ± 1.55^{a}	50.75 ± 1.79^{c}	52.43 ± 2.33^{bc}
	4–6 w	54.81 ± 2.27^{ac}	50.49 ± 2.29^{ab}	49.94 ± 0.75^{b}
	7–9 w	55.41 ± 1.94^{a}	53.85 ± 2.23^{ab}	53.16 ± 1.26^{b}
	1–9 w	56.35 ± 2.77	51.70 ± 2.53^{b}	51.84 ± 2.06^{b}
Egg culling rate (%)	1–3 w	0.84 ± 1.69^{a}	4.25 ± 2.92^{b}	2.22 ± 2.33^{ab}
	4–6 w	2.33 ± 2.57	1.80 ± 1.49	3.89 ± 2.75
	7–9 w	0.43 ± 0.87	0.37 ± 0.74	1.56 ± 2.97
	1–9 w	1.20 ± 1.94^{a}	3.68 ± 3.45^{b}	2.56 ± 2.73^{ab}

Note: Values with different lowercase letters significant difference indicate significant difference ($P < 0.05$).

Ibtisham *et al*. (2019)

Effect of Artemisia on blood pH in broilers

- Cyclic heat stress: 34°C for 8 h/day; 22 °C for 16 h/day)



Wan *et al.* (2017)

Effect of Artemisia on performance

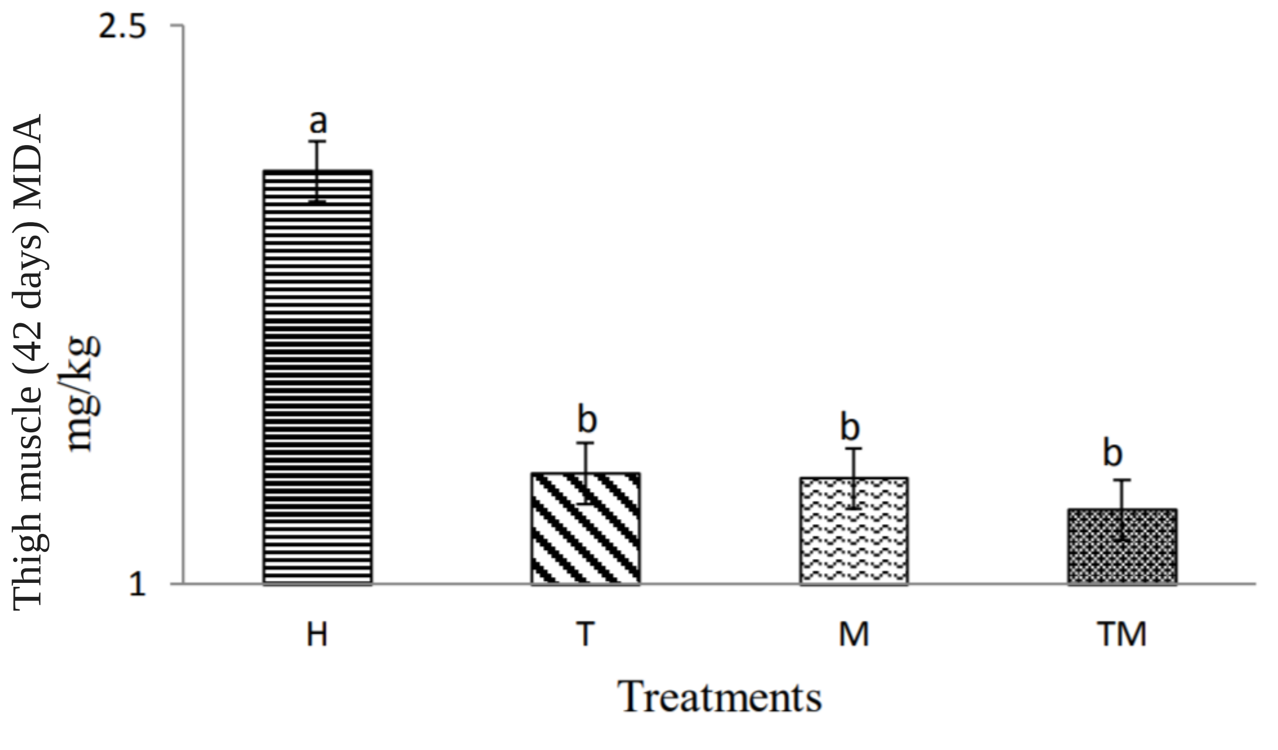
Table 2 Effects of enzymatically treated *Artemisia annua* L. on growth performance of broilers reared under heat stress

Item	Treatment†					SEM
	Control	HS	HS-EA$_{0.75}$	HS-EA$_{1.00}$	HS-EA$_{1.25}$	
BWG, g	1452^{a}	1285^{c}	1339^{bc}	1389^{ab}	1375^{ab}	19.04
FI, g	2694	2541	2582	2656	2625	19.30
G:F, g/g	0.540^{a}	0.506^{b}	0.519^{ab}	0.527^{ab}	0.524^{ab}	0.007
Carcass yield, %	75.28^{a}	70.51^{c}	72.02^{bc}	73.46^{ab}	73.23^{ab}	0.660
Abdominal fat, %	1.389	1.434	1.397	1.410	1.345	0.037

Wan *et al.* (2017)

Effect on Thyme and Squaw Mint on Antioxidant status

- Cyclic heat stress: 32°C for 8 h/day



Pirmohamammadi *et al.* (2016)

Selecting phytogenics candidates for heat stress evaluation

Evaluation and validation of candidates

- Step 1: Survival rate of nematode *C. elegans*
- Step 2: Gene expression in *C. elegans* for HSP-transcription factors
- Step 3: Gene expression in Caco-2 cells for HSP
- Step 4: *In vivo* validation

In vitro evaluation of heat stress: *C. elegans* survival rate

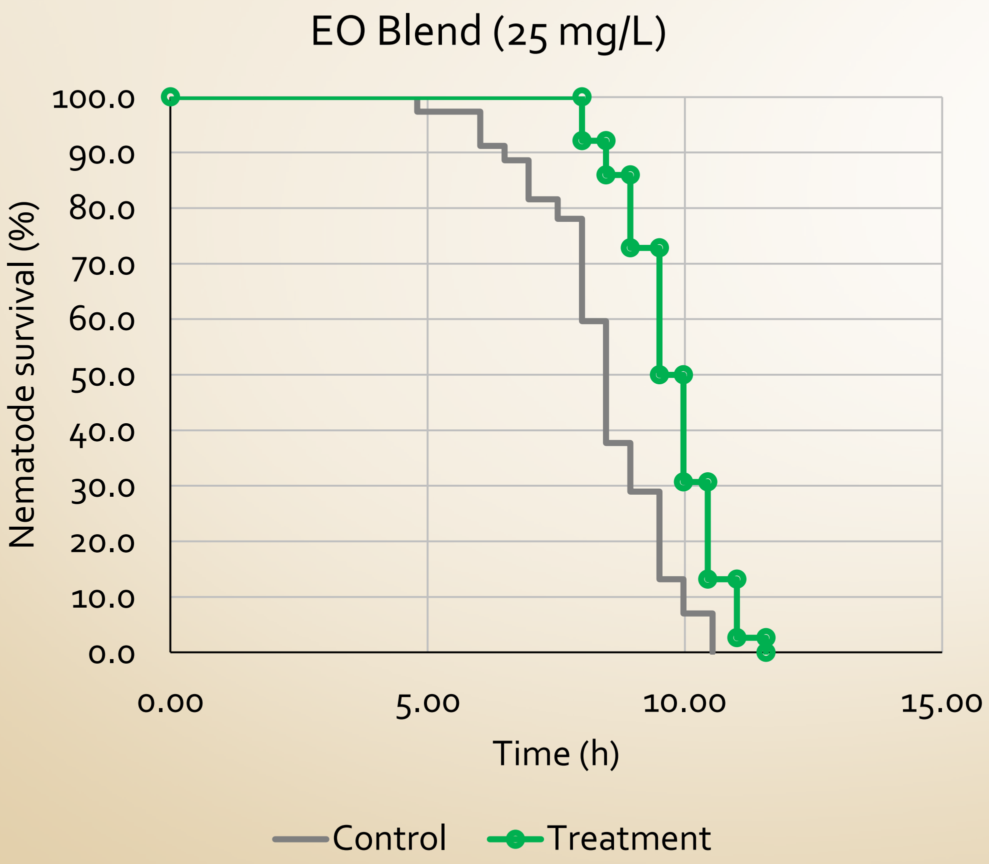
- Free-living nematode, soil dwelling
- Easy to manage

Length: 1 mm, Diameter: 65 µm

1 day	3 days	2 days	7-10 days
Egg	4 Larval stages	Adult	
	Incubated at 20°C	Add test substance	37°C

- Survival rate evaluated every 30 min until all worms dead
- Measured via increase in SYTOX Green fluorescense

Step 1: EO Blend and *C. elegans* survival



Increased survival rate calculated from surface area:

- 7975 minutes

= 15.8% increase relative to control

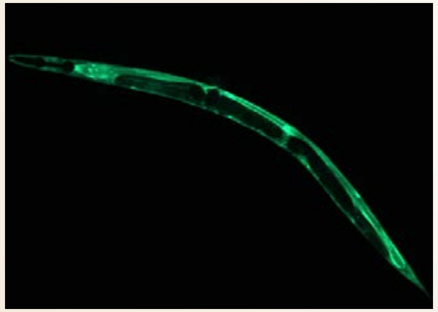
Delacon Internal Study

Step 1: Screening of test substances and *C. elegans* survival

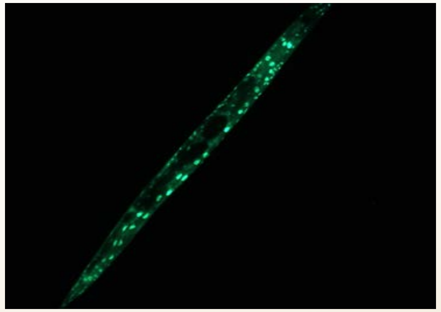
Product	Dose (mg/L)	Survival rate increase (%)
Vitamin C	250	10.9
Vitamin E	150	5.1
Betaine	500	11.3
EO Blend	25	15.8
Flavonoid Blend	250	4.2
Capsaicin oleoresin	500	0.6

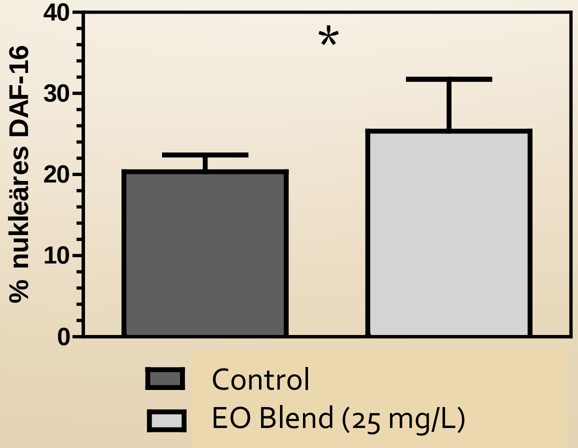
Step 2: *C. elegans* and HSP transcription factors

Unstressed: DAF-16 in in the cytosol

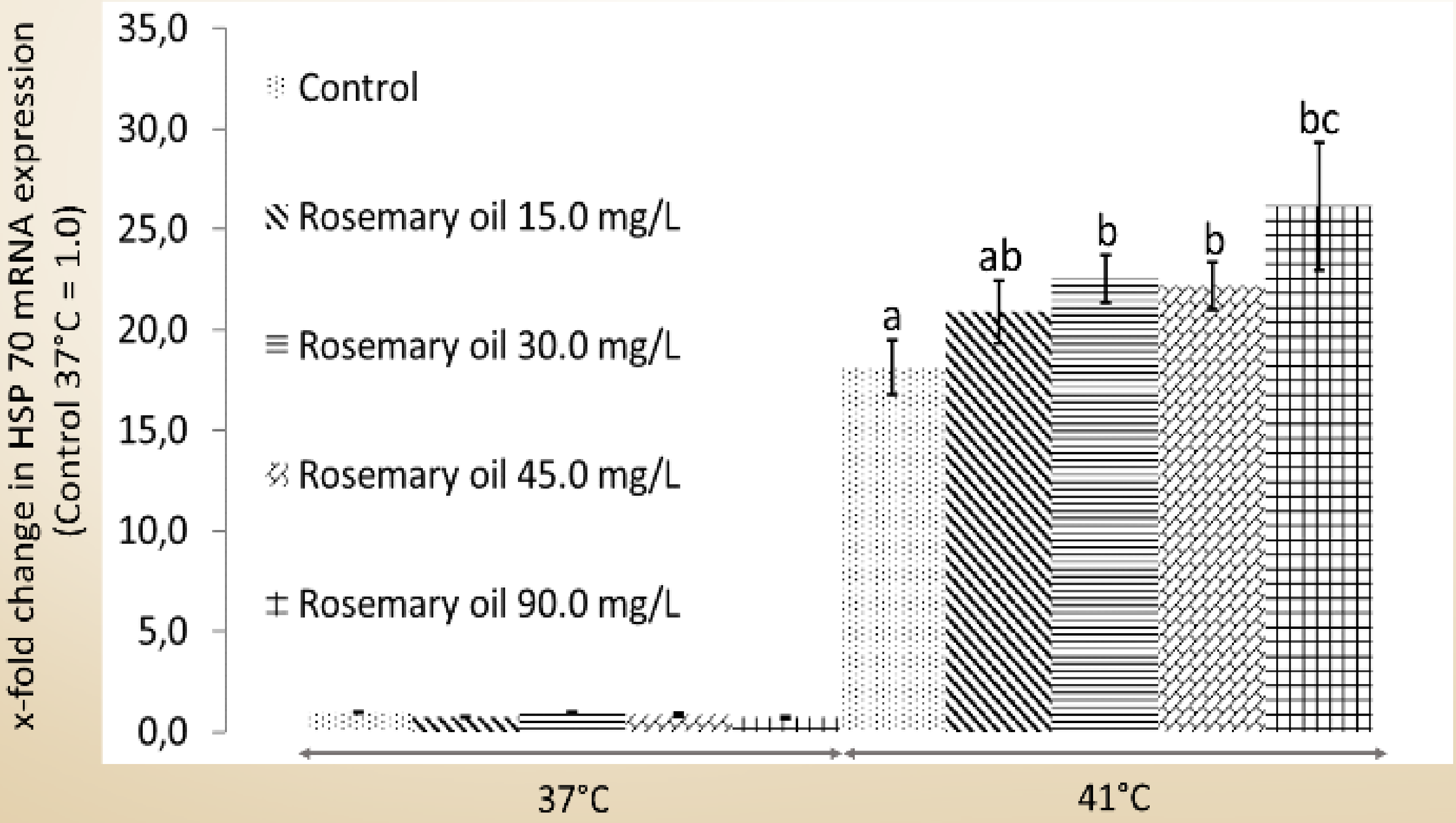


Heat stress: DAF-16 in nucleus where genes are up-regulated for synthesis of HPS70





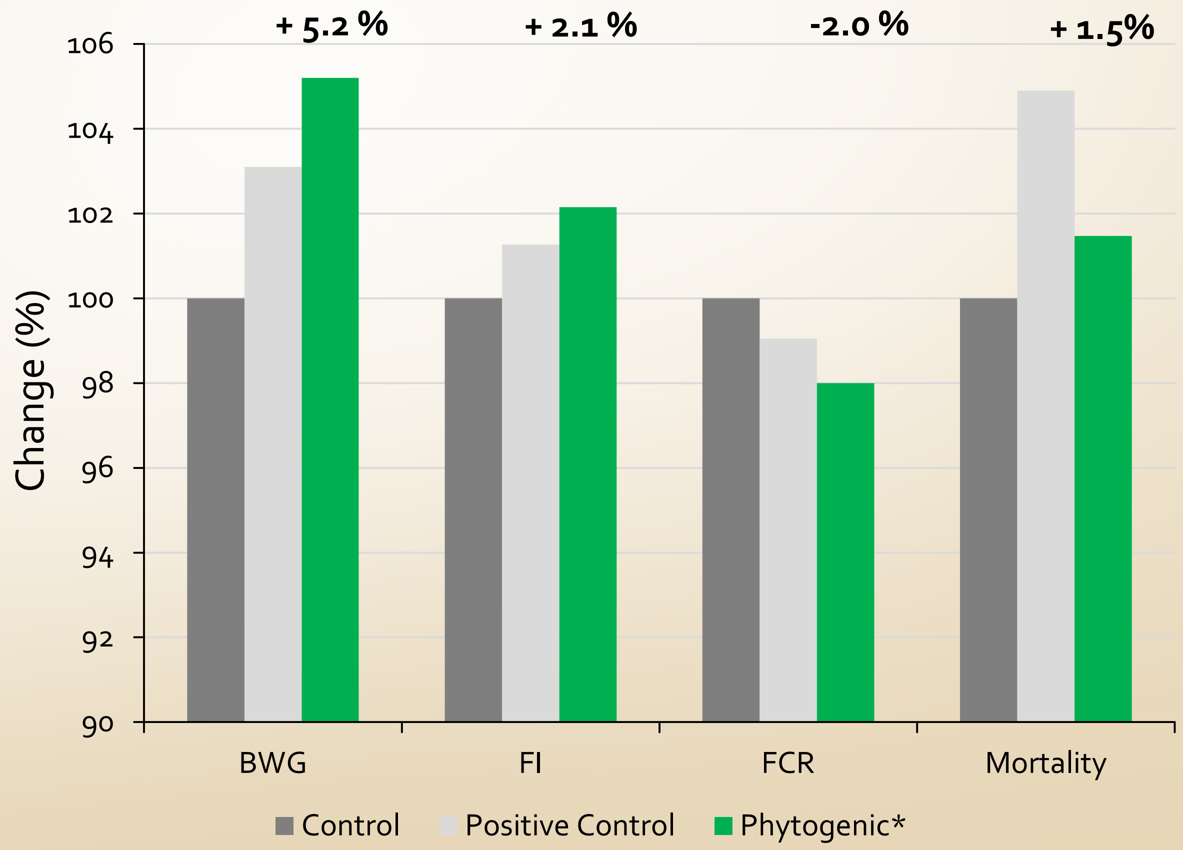
Step 3: Heat-stressed Caco-2 cells



Delacon Internal Study

Step 4: *In vivo* validation phytogenic combinations

- Heat stress: cyclic (8h at 32°C; 12h at 26°C); from d21-42 of age
- Diet: Corn/Wheat based diet Betaine positive control
- Birds: 576 broilers (Ross 308)
- Duration: 42 days
- Design: 6 reps, 32 birds each
- Performance negative control: BWG: 2543 g; FCR: 1.767; Mort.: 3.4%

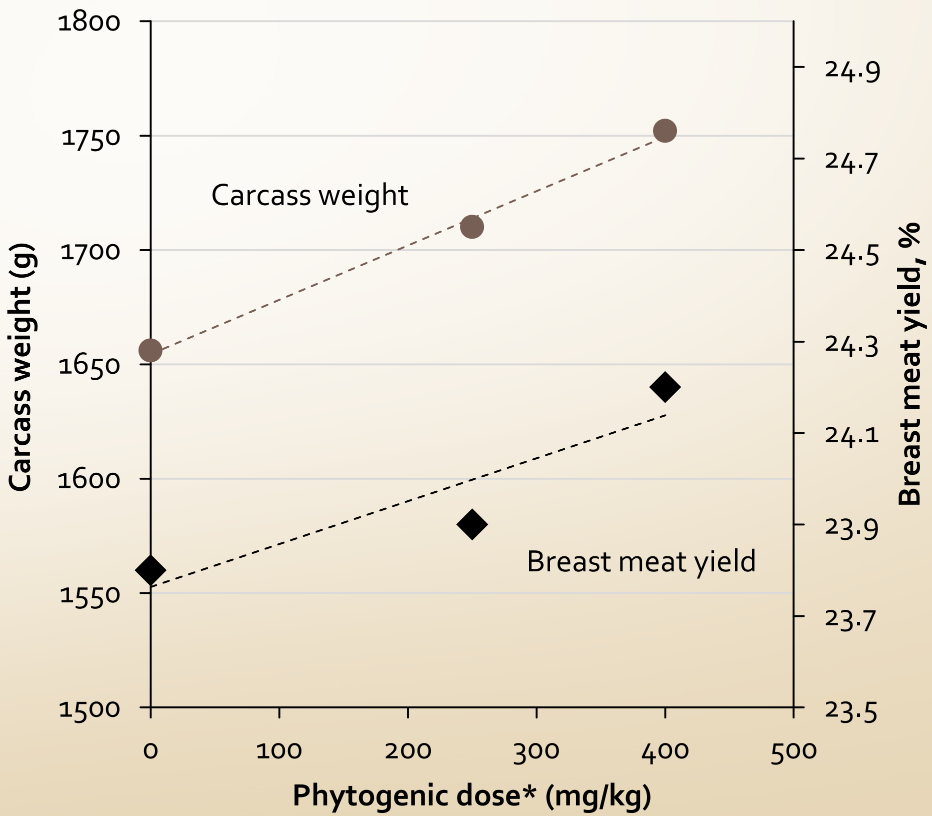


* Essential oil, flavonoids & pungent substances (Biostrong® Comfort)

Delacon internal study

Step 4: *In vivo* validation phytogenic combinations

- Heat stress: cyclic (12h at 35°C; 12h at 24°C) from d21-42 of age
- Diet: 3-Phase corn/soy-based diet
- Birds: 600 broilers (Cobb 500)
- Duration: 42 days
- Design: 4 reps, 25 birds each

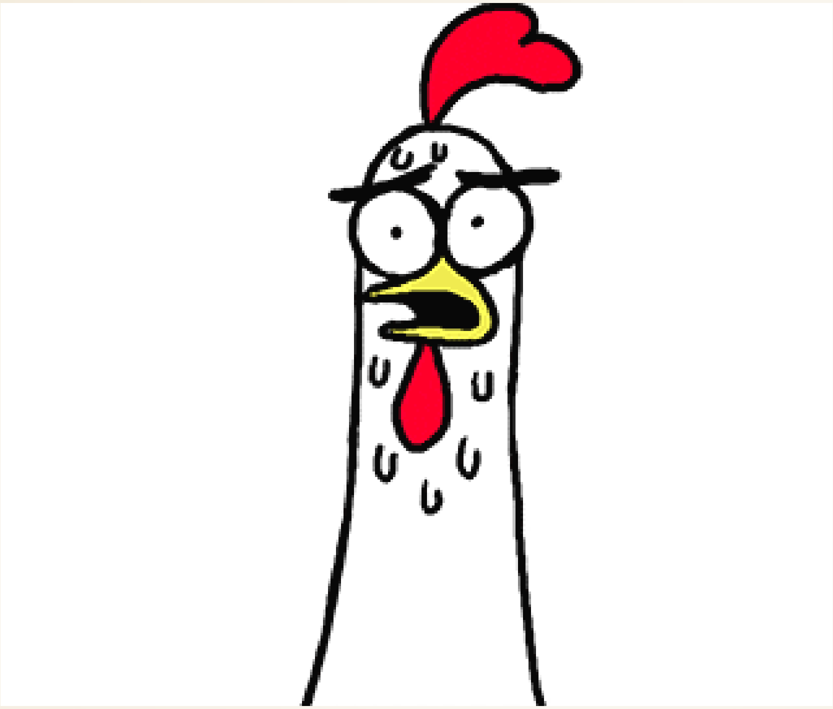


* Essential oil, flavonoids & pungent substances

Delacon internal study

Summary

- Thermal stress can have deleterious impacts upon production performance
- Phytogenic feed additives are one strategy to manage heat stress
- Significant body of research supports phytogenics efficacy
- Screening and validation methodologies deliver targeted, efficacious products
- Phytogenic combinations can prove highly effective e.g. combinations of essential oils, flavonoid and pungent substances
- Globally, it's only going to get hotter!



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