广东省农科院动物科学研究所
Institute of Animal Science,
Guangdong Academy of Agricultural Sciences

Effects of Dietary Threonine Levels on Performance and Offspring Traits in Breeder Hens of Yellow Chicken

Speaker: Shouqun Jiang

Institute of Animal Science,
Guangdong Academy of Agricultural Sciences,
Guangzhou 510640, China

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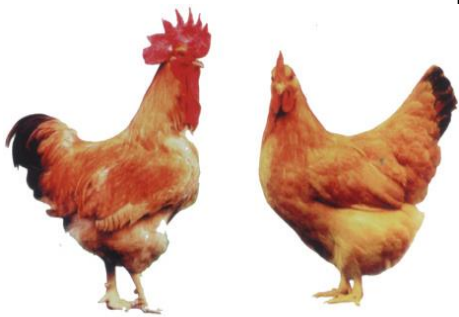
Institute of Animal Science, Guangdong Academy of Agricultural Sciences, China

- Animal breed and genetics
- Animal nutrition and feed
- Grass science
- Aquaculture
- Animal health and medicine

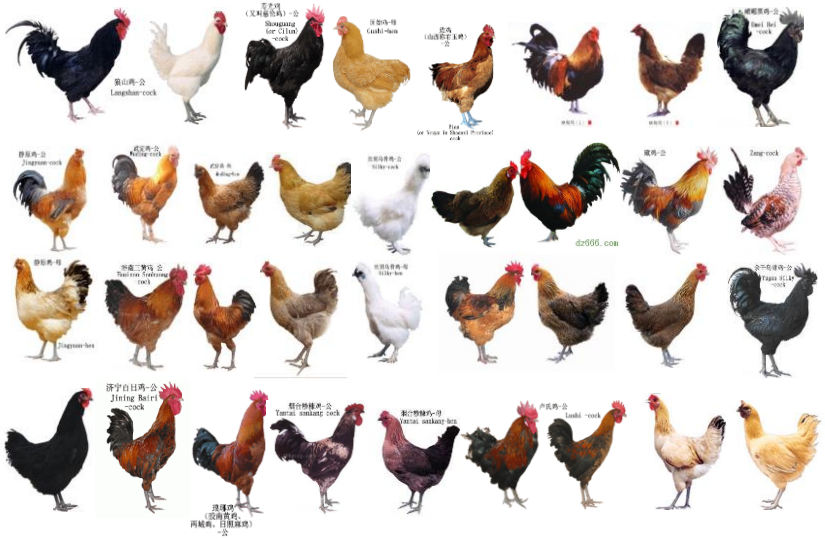
Outline

- Background
- Materials and methods
- Results and discussion
- Conclusion
- Acknowledgements



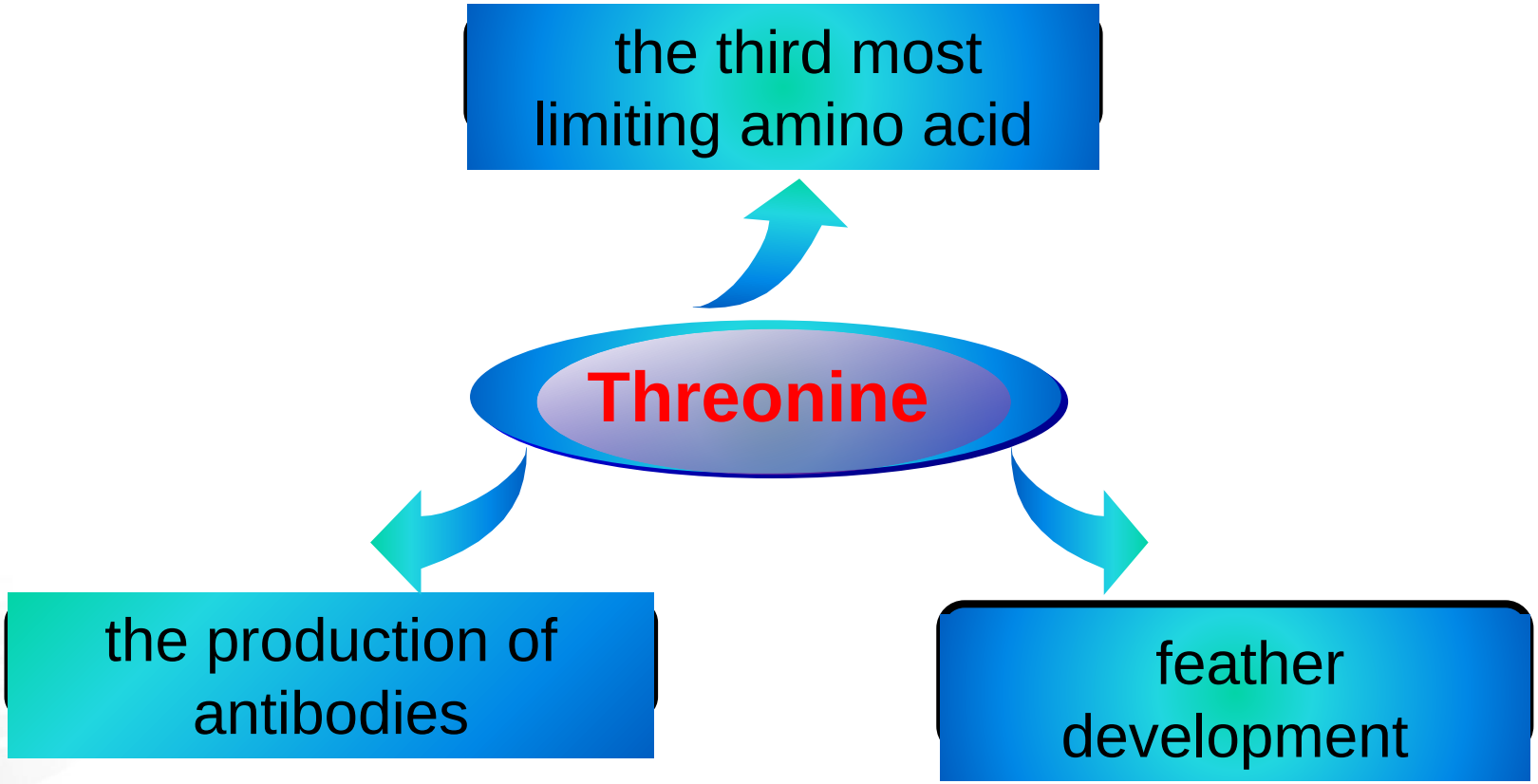
Background

Chinese yellow-feathered broiler chickens are one of the most important meat resource in China.



The production of Yellow-feathered broilers has reached over 3.7 billion annually (Tang et al., 2012; Jiang et al., 2017).

Background


the third most limiting amino acid
Threonine
the production of antibodies
feather development

Background (cont.)

- In poultry, Thr deficiency has negative effects on the growth performance, carcass yield, and quality by reducing the thigh and breast yield, increasing body fat deposition, inhibiting feather development, and decreasing antibody formation, as well as having positive effects on the mortality rate (Fouad and El-Senousey, 2014; Min et al., 2017; Bi et al., 2018)；

Background (cont.)

- In laying hens, dietary supplementation with L-Thr enhances egg production, the egg weight, feed conversion ratio, and antibody production during different phases of production and at different ambient temperature ranges (Azzam et al., 2014; Cardoso et al., 2014);
- Dietary Thr supplementation improved growth performance, mucin secretion, and the humoral immune response in broiler chickens and quails (Kadam et al., 2008; Kermanshahi et al., 2015);
- In laying ducks, Thr deficiency reduced the egg production, egg weight, and egg mass (Fouad et al., 2017).

Background (cont.)

However, no report has investigate the effect of dietary Thr on productivity, reproductive performance, protein metabolism, and offspring traits in breeder hens of Yellow chicken.

- Investigate the effects of dietary Thr level in breeder hens of Chinese Yellow chicken on performance, embryo amino acid transportation and protein deposition, and offspring traits.
- Estimate the optimal dietary Thr level of breeder hens of Chinese Yellow chicken.

Materials and methods

- 720 breeder hens of Chinese yellow chicken, 197-d-old.
- 6 groups with 6 replicates of 20 birds each.
- Corn-wheat-peanut meal based diet (Thr: 0.38%)
- Levels of Thr addition were 0%, 0.12%, 0.24%, 0.36%, 0.48%, and 0.60%, respectively.

Treatments	1	2	3	4	5	6
Dietary Thr levels (%)	0.38	0.50	0.62	0.74	0.86	0.98

Materials and methods

Composition and nutrient levels of the basal diet (as-fed basis , g/kg)

Ingredients	%	Nutrient composition	Contents
Corn	413	AME (MJ/kg)	11.50
Wheat	325	CP	168.10
Peanut meal	141	Ca	28.33
L-lysine HCl	5.3	Total phosphorus	6.14
DL-methionine	4.1	Non-phytate phosphorus	4.10
L-threonine	0.0	Lysine	8.61
Tryptophan	0.8	Methionine	5.41
Isoleucine	1.9	Met+Cys	7.30
Limestone powder	68.5	Threonine	3.80
Dical phosphate	16.8	Tryptophan	2.10
Zeolite (carrier)	10.6	Isoleucine	5.90
Salt (NaCl)	3		
Vitamin-mineral premix	10		
Total	1000		

Composition and nutrient levels of the basal diet for progeny chickens (as-fed basis , g/kg)

Ingredients	Contents	Nutrient composition	Contents
Corn	584.0	AME (MJ/kg)	12.13
Wheat shorts	42.5	CP	210.0
Fish meal	22.0	Ca	10.0
Soybean meal	264.0	TP	6.8
Corn gluten meal	20.0	Non-phytate P	4.5
Soybean oil	13.0	Lys	10.5
DL-met	1.0	Met	4.6
Limestone powder	12.7	Met+Cys	8.5
Dical phosphate	15.1	Thr	7.6
Salt (NaCl)	3.0	Trp	1.9
Zeolite (carrier)	12.7	Ile	7.6
Vitamin-mineral premix	10.0		
Total	1000.0		

Statistical Analysis

- Replicate (average of the 2 birds for variables measured after slaughter) served as the experimental unit. Effects of dietary Thr were examined by one-way ANOVA using the GLM procedure of SAS (ver. 8.02, SAS Inst. Inc., Cary, NC).
- In addition, pairwise comparisons between means were assessed with Duncan's multiple range tests at $P < 0.05$ probability levels. Where appropriate, quadratic regressions ($Y = c + bx + ax^2$) were fitted to the responses of the dependent variables to Thr supplementation. The dietary concentration of Thr at which the response reached 95% of the maximum was estimated as the requirement (Coma et al., 1995; Robbins et al., 2006).

Results & Productive performance

- No significant effects of Thr supplementation on ADG, average daily egg mass, average daily egg weight, feed conversion ratio, egg weight, and unqualified egg rate ($P > 0.05$).

Variable	Thr supplementation (bold) and (total dietary content, %)					
	0.00(0.38)	0.12 (0.50)	0.24 (0.62)	0.36 (0.74)	0.48 (0.86)	0.60 (0.98)
Initial BW (g)	2976.3±29.5	2990.0±22.5	2975.0±24.6	3003.0±25.0	2966.3±22.5	2967.5±31.5
Final BW (g)	3134.7±48.9	3162.5±38.7	3159.1±39.4	3123.8±113.4	3062.7±190.4	3145.4±57.0
Average daily gain (g)	2.44±0.73	2.65±0.37	2.83±0.68	1.85±1.96	1.48±2.97	2.74±0.55
Average daily egg production (g)	41.74±1.41	42.97±1.89	41.25±2.02	42.02±1.62	41.92±1.88	41.33±1.92
Average daily feed intake (g)	125	125	125	125	125	125
Feed conversion ratio (kg feed/kg egg)	3.12±0.10	3.03±0.14	3.16±0.15	3.10±0.12	3.11±0.13	3.15±0.15
Livability (%)	98.33±2.58	99.17±2.04	98.33±2.58	97.50±2.74	96.67±4.08	100.00±0.00

Laying performance, fertility and hatchability

- Graded levels of Thr produced quadratic (R^2=0.2176，P=0.0495) positive responses in laying rate, and maximal laying rate was obtained with 0.12 % Thr, regression estimates of 0.30 % of Thr in the diet gave maximal laying rate ($P < 0.05$).
- Hatchability of eggs was higher fed 0.12% and 0.24% Thr than control (P<0.05).

Variable	Thr supplementation (bold) and (total dietary content, %)					
	0.00(0.38)	0.12 (0.50)	0.24 (0.62)	0.36 (0.74)	0.48 (0.86)	0.60 (0.98)
Laying performance						
Laying rate (%)	70.02±1.13^{b}	73.29±2.44^{a}	71.92±2.73^{ab}	72.51±1.12^{ab}	71.77±2.45^{ab}	70.27±2.38^{ab}
Average egg weight (g)	58.13±1.07	58.50±1.30	57.97±1.10	57.68±0.66	57.74±0.82	58.49±1.03
Broken egg rate (%)	0.95±0.31	1.08±0.43	0.94±0.55	0.77±0.32	1.19±0.47	0.93±0.44
Unqualified egg rate (%)	2.62±0.98	3.22±0.55	2.79±1.15	3.48±1.47	3.11±1.61	3.07±1.22
Fertility and hatchability						
Fertilization rate (%)	95.67±3.20	96.67±3.50	95.60±3.29	95.60±2.61	95.60±2.61	96.00±2.45
Hatchability (%)	75.00±9.22 ^{b}	83.00±4.81 ^{a}	83.75±7.37 ^{a}	76.25±5.42^{b}	78.75±7.54 ^{b}	77.92±7.32 ^{b}
Hatchling weight (g)	40.25±0.56	40.71±0.43	40.15±0.70	40.43±0.88	40.81±0.28	40.59±0.61
Quadratic regression model‡						
Variable	Model equation		R square	P value	ER, %	FE, %
Laying rate (%)	$Y=70.41+16.45X-27.57X^2$		0.6707	0.0295	0.30	0.12

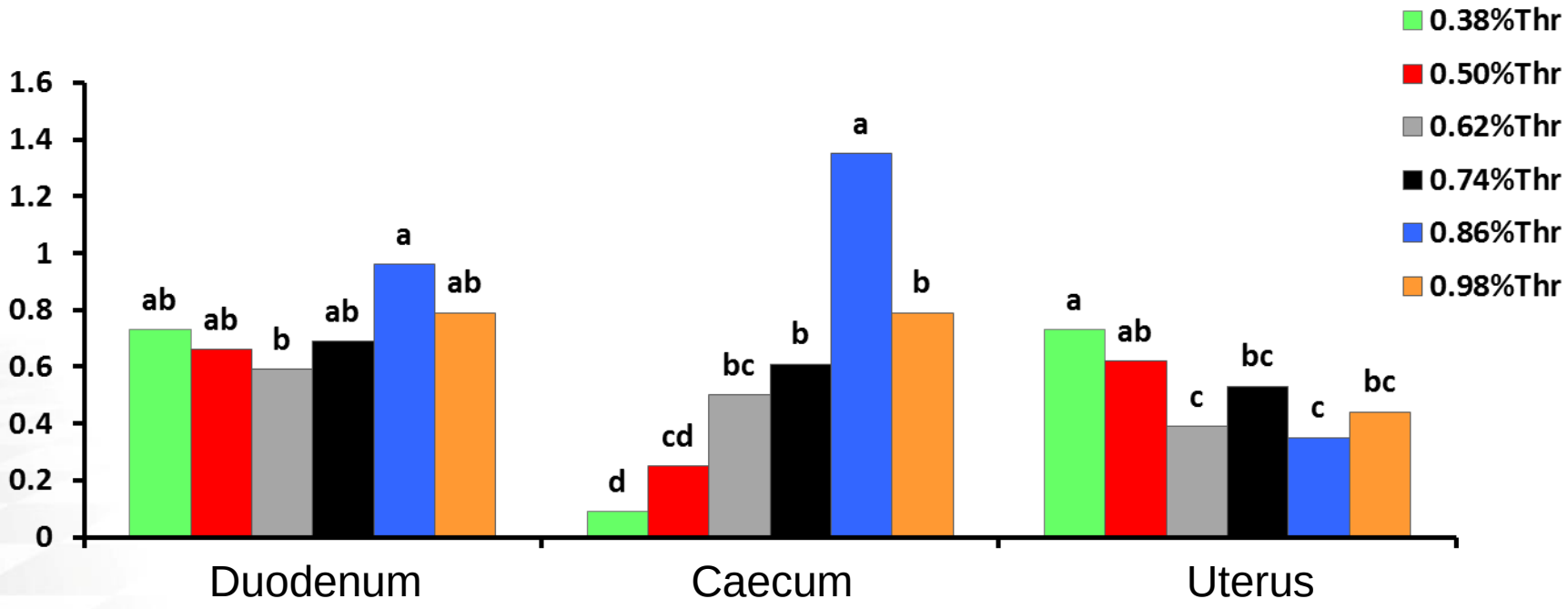
Reproductive organs and follicle development

- No differences were observed in the weights of ovary and oviduct, large follicle number and total large follicle weight ($P > 0.05$)

Variable	Thr supplementation (bold) and (total dietary content, %)					
	0.00(0.38)	0.12 (0.50)	0.24 (0.62)	0.36 (0.74)	0.48 (0.86)	0.60 (0.98)
Ovary weight (g)	62.33±7.00	55.35±9.81	55.56±14.19	55.86±8.44	59.44±10.31	63.33±6.21
Oviduct weight (g)	63.74±7.36	55.08±5.45	58.45±9.88	55.27±4.08	57.98±5.81	60.68±8.46
Large follicle number	6.08±0.86	5.25±0.94	5.25±0.76	5.00±0.84	5.25±0.94	5.92±0.74
Total large follicle weight (g)	52.32±8.44	43.12±10.35	44.11±13.83	43.02±7.63	46.75±10.13	51.06±4.39

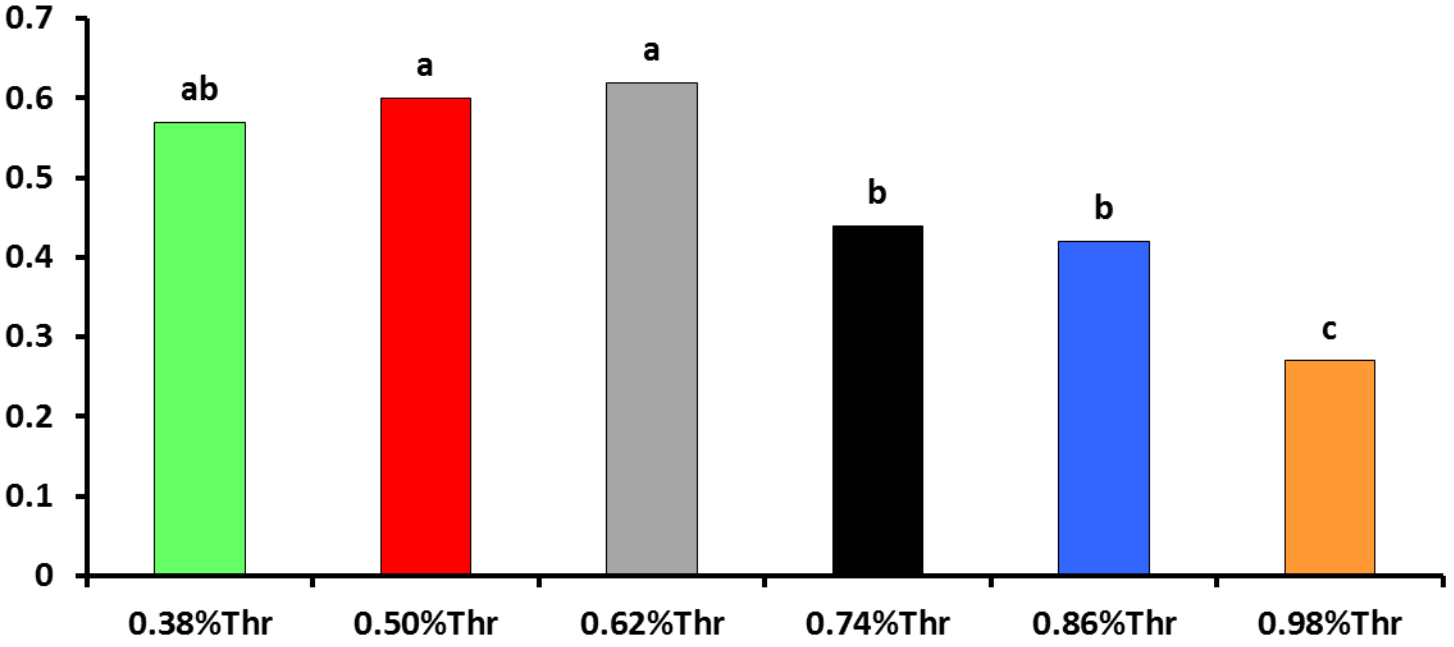
Results & MUC2 gene expressions

- There was an increase in MUC2 transcripts in caecum with added Thr, with maximal expression with 0.48% and somewhat less with 0.36% and 0.60%.
- With the exception of the 0.12% Thr diet, that dietary adding Thr decreased the relative expression of MUC2 in uterus (P < 0.05).



Results & ZO-1 gene expressions

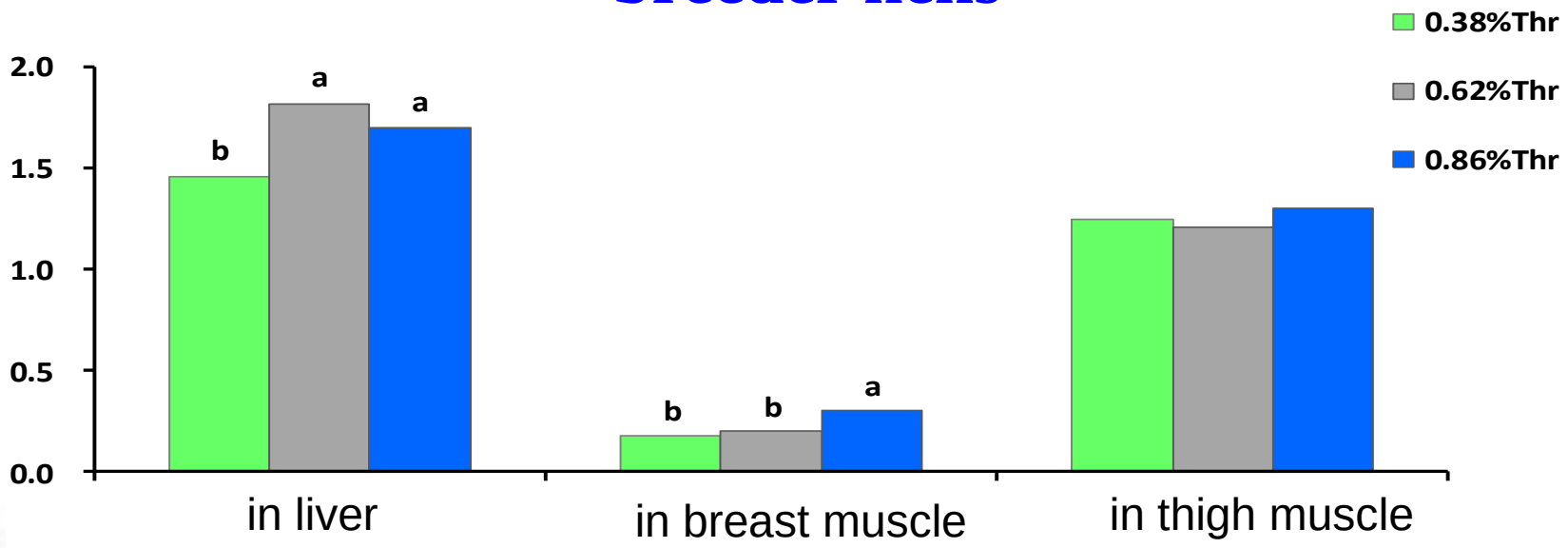
Effects of dietary threonine levels on ZO-1 gene expressions in duodenum of breeder hens



- ZO-1 transcript in duodenum decreased with the increase of dietary Thr level, which was higher with added 0.12% and 0.24% Thr than 0.36%, 0.48% and 0.60% Thr ($P<0.05$), and still higher with added 0.36% and 0.48% Thr than 0.60% Thr ($P<0.05$).

Results & pTOR gene expressions

Effects of dietary threonine levels on pTOR gene expressions in liver and muscle of chick embryo of breeder hens



- There were significant upregulations of dietary Thr levels on the transcripts of pTOR in liver and breast muscle of chick embryo, TDH in thigh muscle, AP in duodenum and ileum ($P<0.05$)

Results & growth of progeny broilers

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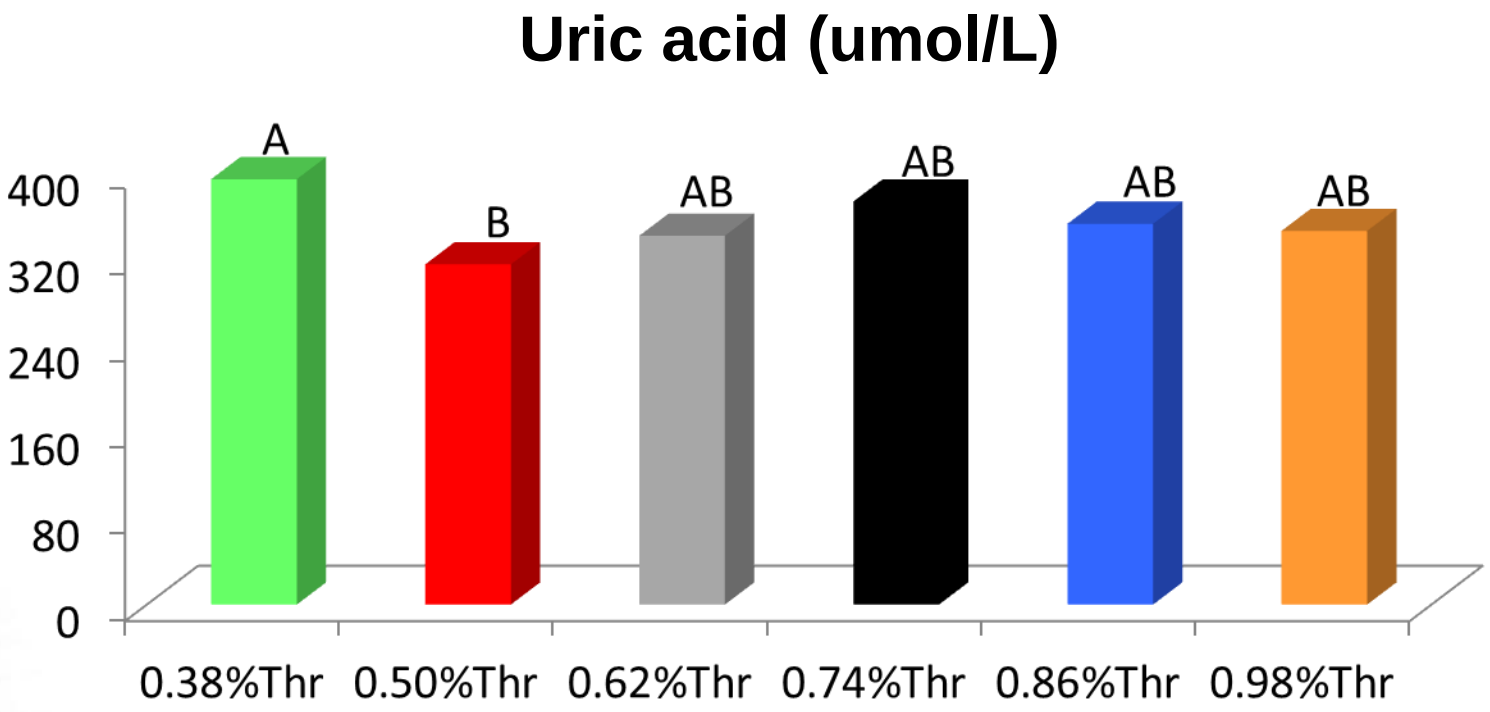
Effects of dietary threonine levels on growth performance of progeny broilers aged from 1d to 21 d

Variable	Thr supplementation (bold) and (total dietary content, %)					
	0.00(0.38)	0.12 (0.50)	0.24 (0.62)	0.36 (0.74)	0.48 (0.86)	0.60 (0.98)
Final weight (g)	382.6±18.7^{ab}	391.2±16.8 ^{ab}	410.7±17.9^{a}	378.9±11.9^{b}	393.9±24.1^{ab}	400.4±31.1^{ab}
ADG (g)	16.30±0.87^{ab}	16.69±0.79 ^{ab}	17.64±0.85^{a}	16.15±0.58^{b}	16.82±1.14^{ab}	17.13±1.45^{ab}
ADFI (g)	29.64±2.38	29.72±0.68	30.73±2.46	29.18±1.22	28.43±3.06	29.60±2.65
FCR	1.78±0.08	1.80±0.05	1.83±0.15	1.83±0.06	1.78±0.09	1.80±0.04
Livability (%)	93.02±9.69^{b}	99.51±1.20^{a}	99.49±1.24^{a}	97.74±2.80^{ab}	96.28±3.23^{ab}	97.91±1.62^{ab}

- **Supplemental Thr 0.24% increased ADG by 8.22% 。**
- **Supplemental Thr 0.12% and 0.24% increased livability of chickens more than 6%.**

Results & plasma variables of progeny

Effects of dietary threonine levels on biochemical variables in plasma of progeny broilers aged from 1d to 21 d



- **Supplemental Thr 0.12% decreased plasma uric acid content of chickens** ($P<0.05$).

Conclusion

- There were positive effects of supplemental dietary Thr on laying production of breeder hens and offspring performance, and this was associated with the regulations of gene expressions related to amino acid transportation and protein desposition.
- The optimal dietary Thr level was 0.68% or 0.85 g per hen per day for breeder hens of yellow chicken aged from 197d to 253d.

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◆Research team:

Dr. Zhongyong Gou

Dr. Yibing Wang

Dr. Long Li

Assistant researcher Xiajing Lin

Assistant researcher Qiuli Fan

Associate professor Fayuan Ding


Thanks!

Comments?