

Amino Acid Nutrition in Pigs and Chickens

성 정 열

Sung, Jung Yeol

(부산대학교)

(Pusan National University)

Curriculum Vitae

- ▶ 2026~현재 부산대학교 동물생명자원과학과 조교수
- ▶ 2024~2026 미국 노스캐롤라이나 주립대학교 박사후연구원
- ▶ 2020~2024 미국 퍼듀대학교 축산학과 농학박사
- ▶ 2018~2020 건국대학교 동물자원과학과 농학석사
- ▶ 2012~2018 건국대학교 동물자원과학과 농학사



Amino acid nutrition in pigs and chickens

Jung Yeol Sung

Pusan National University

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 - **Impact of coccidia challenge on lysine requirement in broiler chickens**
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- **Conclusion**

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Introduction



➤ Roles of amino acids (AA)

- **Building blocks** for protein synthesis
- **Functional AA** that **regulate key metabolic pathways** that are necessary for maintenance, growth, reproduction, and immunity

Wu, 2010 3

Introduction



➤ Essential (indispensable) amino acids (EAA)

- AA which **cannot be synthesized** or **inadequately synthesized** by body to meet physiological needs
- Must be provided from diets

➤ Non-essential (dispensable) amino acids (NEAA)

- AA which can be **adequately synthesized** by body to meet physiological needs
- Not considered in typical diet formulation

Wu, 2010 4

Introduction



- **AA requirement (expressed as % in diet)**
 - **May change in response to immune challenges**
 - **Reduced feed intake**
 - **AA need for maintenance + AA need for production**



Litvak et al., 2013; Rakhshandeh et al., 2014; Wellington et al., 2018; Jespersen et al., 2024 5

Introduction



- **Low-protein diet**
 - **Partial replacement of SBM with supplemental AA**
 - **However, excessive reduction in dietary protein may induce NEAA deficiency**
 - **Catabolism of EAA for NEAA production**
 - **Compromised growth and intestinal health considering the functional roles of NEAA**

Heger et al., 1998; Kim et al., 2007; Wu, 2010 6

Introduction



➤ Hypotheses

- **Coccidia challenge** increases lysine requirement of broiler chickens
- **NEAA deficiency** impairs intestinal health & growth when nursery pigs are fed a SBM-free diet
- **Increasing NEAA supplementation** in SBM-free diets gradually restores intestinal health & growth of nursery pigs

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Introduction



➤ Objectives

- **Investigate the impact of coccidia challenge on lysine requirement of broiler chickens**
- **Investigate the impact of graded concentrations of NEAA in SBM-free diets on intestinal health & growth of nursery pigs**

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Exp. 1: Materials and methods



- **490 birds on from d 8 to 16 post-hatch**
- **Randomized complete block design**
- **5 (lysine) × 2 (challenge) factorial**
 - **SID lysine: 0.85, 1.00, 1.15, 1.30, and 1.45%**
 - **Challenge: Saline or *Eimeria* gavage on d 9**

125,000 (*Eimeria acervulina*)

25,000 (*Eimeria maxima*)

25,000 (*Eimeria tenella*)

oocysts



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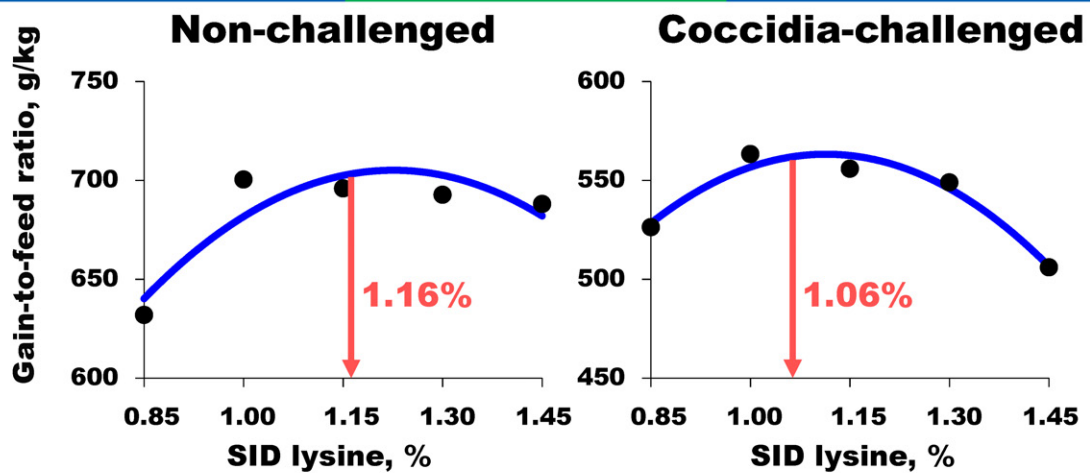
Exp. 1: Materials and methods



	SID lysine, %				
	0.85	1.00	1.15	1.30	1.45
Feedstuff, %					
Corn	71.775	71.775	71.775	71.775	71.775
Soybean meal	22.000	22.000	22.000	22.000	22.000
L-Lysine HCl	0.155	0.345	0.535	0.725	0.915
L-Glutamic acid	1.210	0.910	0.610	0.310	-
Cornstarch	-	0.110	0.220	0.330	0.450
Crude protein, %	18.5	18.5	18.5	18.5	18.5
SID lysine, %	0.85	1.00	1.15	1.30	1.45

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Exp. 1: Results



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Exp. 2: Materials and methods



- **48 weaned pigs (initial BW = 6.7 kg)**
 - Randomized complete block design
 - Individually housed
 - 28 d in 3 phases (wean to 7 kg / 7 to 11 kg / from 11 kg)
- **4 diets**
 - **NC: Corn-SBM diet**
 - **PC: SBM-free diet**
 - **PC+50NEAA: PC + 50% of NEAA contribution from SBM in NC**
 - **PC+100NEAA: PC + 100% of NEAA contribution from SBM in NC**

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Exp. 2: Materials and methods



	Phase 1 (wean to 7 kg)				Phase 2 (7 to 11 kg)				Phase 3 (from 11 kg)			
	NC	PC	PC+ 50 NEAA	PC+ 100 NEAA	NC	PC	PC+ 50 NEAA	PC+ 100 NEAA	NC	PC	PC+ 50 NEAA	PC+ 100 NEAA
Feedstuff, %												
Corn	39.33	51.78	48.92	45.63	48.74	63.37	60.08	56.30	59.18	77.21	73.15	68.49
SBM	19.00	-	-	-	22.00	-	-	-	27.00	-	-	-
Supp. EAA	0.65	3.32	3.36	3.40	0.68	3.72	3.75	3.79	0.68	4.55	4.61	4.66
Supp. NEAA	-	-	2.07	4.14	-	-	2.39	4.78	-	-	2.93	5.86
			↑ 50%				↑ 50%				↑ 50%	
SID EAA, %	9.80	8.90	8.90	8.90	8.98	7.88	7.88	7.88	8.36	7.18	7.18	7.18
SID NEAA, %	10.65	6.80	8.73	10.65	9.85	5.41	7.64	9.85	9.11	3.66	6.39	9.11

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Exp. 2: Materials and methods



➤ Jejunal mucosa & tissue collection on d 28

- Jejunal mucosa-associated microbiota
- Jejunal tissue & mucosa
 - Gene expression
(NOD1/2, TLR2/4, CD14, NF-κB, IFN, CLA, OCC, ZO1, mTOR, and MUC2)
 - Immune response (IL-6, IL-8, TNF-α, and IgA)
 - Oxidative damage products (protein carbonyl and MDA)
 - Morphology (villus height, crypt depth, and Ki-67⁺ cell)

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Exp. 2: Materials and methods

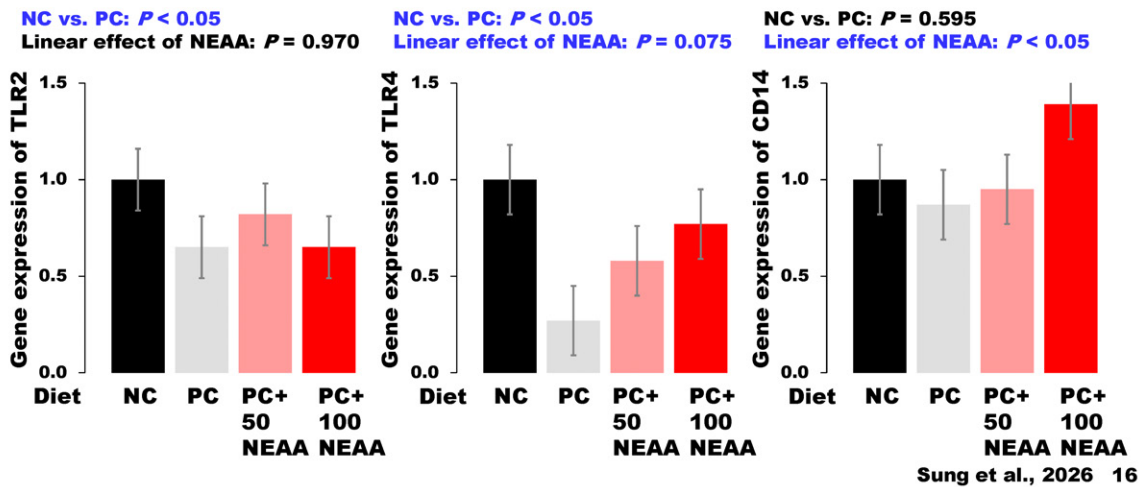


➤ Statistical analysis

- Growth & intestinal health data
 - Proc MIXED of SAS (fixed: diet, random: initial BW, sex)
 - Contrasts: NC vs. PC; linear effect of NEAA
- Nutritional needs of NEAA
 - Proc NLIN of SAS (broken-line analysis)
- Significance: $P < 0.05$; tendency: $0.05 \leq P < 0.10$

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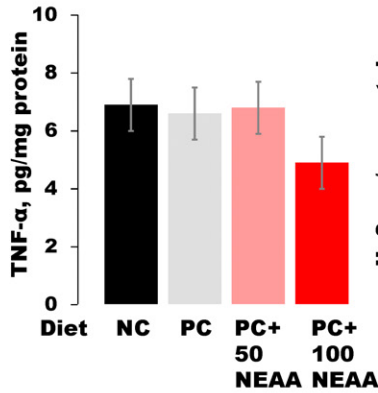
Exp. 2: Jejunal gene expression



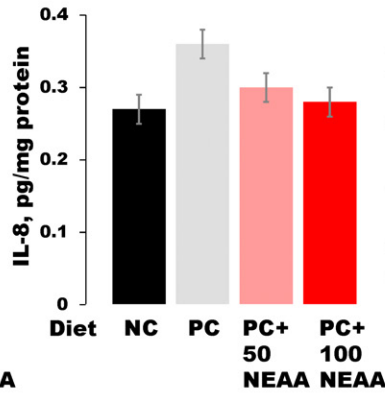
Exp. 2: Jejunal immune responses



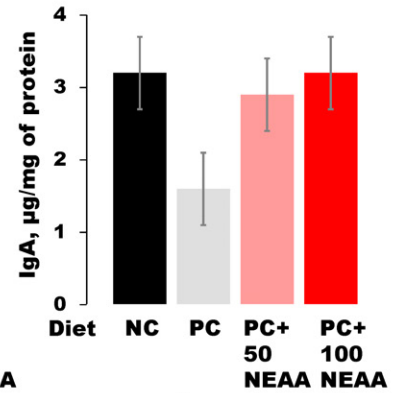
NC vs. PC: $P = 0.820$
Linear effect of NEAA: $P = 0.228$



NC vs. PC: $P < 0.05$
Linear effect of NEAA: $P < 0.05$



NC vs. PC: $P < 0.05$
Linear effect of NEAA: $P < 0.05$

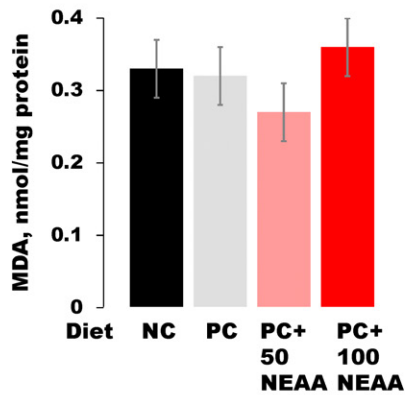


Sung et al., 2026 17

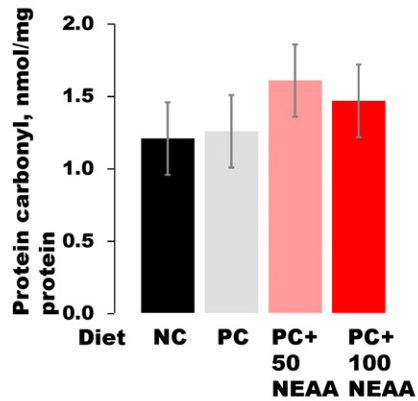
Exp. 2: Jejunal oxidative damage



NC vs. PC: $P = 0.856$
Linear effect of NEAA: $P = 0.449$

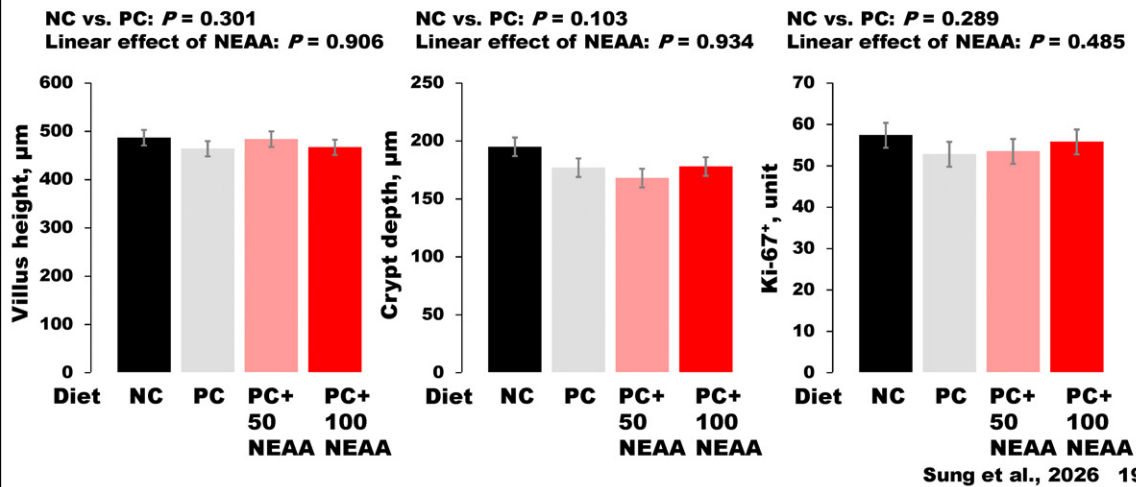


NC vs. PC: $P = 0.904$
Linear effect of NEAA: $P = 0.548$

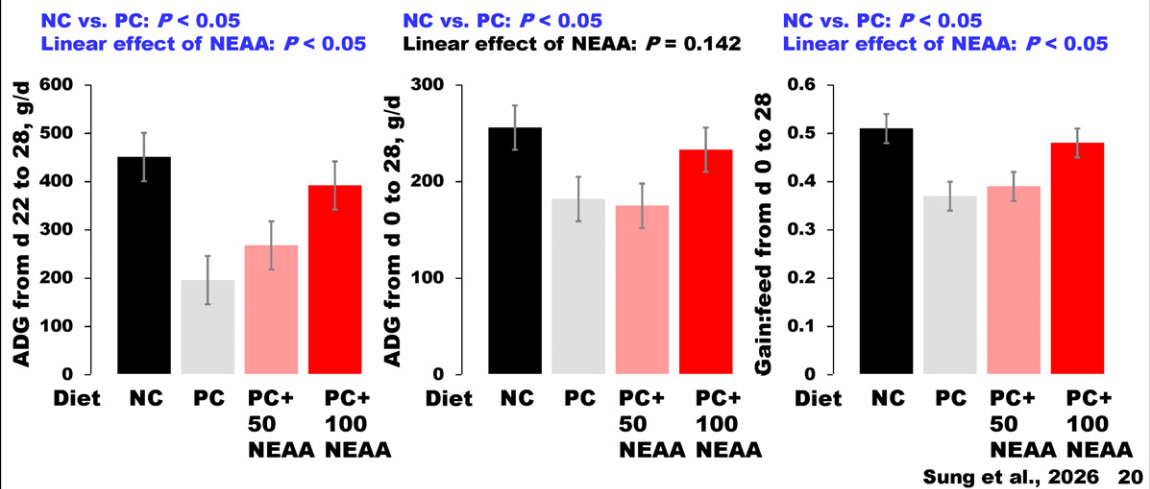


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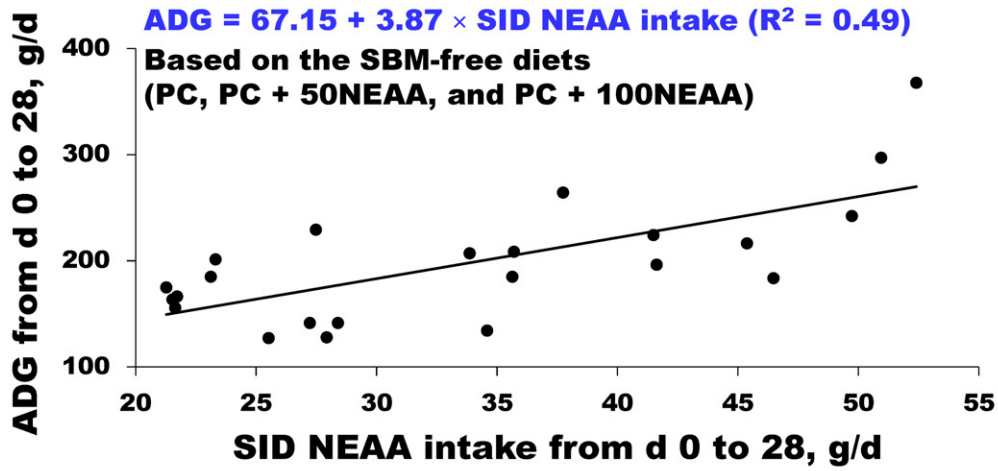
Exp. 2: Jejunal morphology



Exp. 2: Growth performance



Exp. 2: Nutritional needs of NEAA



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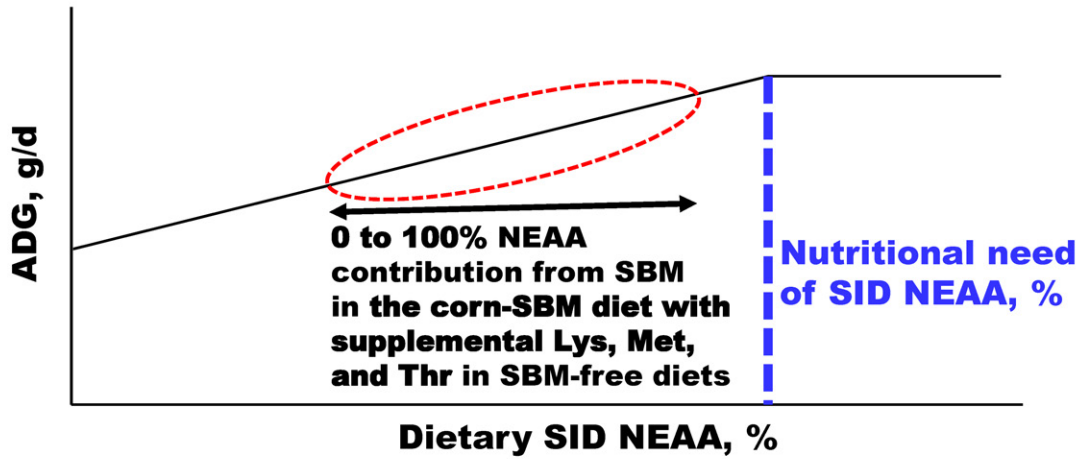
Conclusion



- **Coccidia** may not alter Lys requirement of broilers
- The **SBM-free diet** impaired the jejunal immune responses and growth of pigs, whereas increasing NEAA mitigated the negative impacts
- **NEAA ≥ 100% contribution from SBM** in the corn-SBM diet with supplemental Lys, Met, and Thr may be necessary to optimize growth of nursery pigs fed SBM-free diets

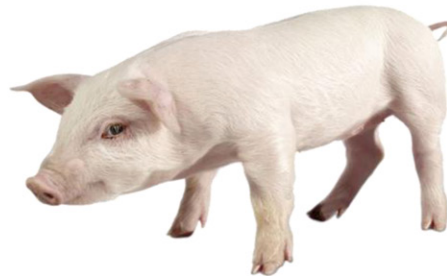
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Conclusion



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Thank you



Jung Yeol Sung, Ph.D.
Assistant Professor
Department of Animal Science
Pusan National University

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