



단위영양

Effects of various dietary fiber sources on growth performance, hematological parameters, and fecal score in weaning pigs

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This study was conducted to evaluate the effects of different dietary fiber sources on the growth performance, hematological parameters, and fecal score of weaning pigs. A total of 150 weaning pigs (7.64 ± 0.068 kg) were assigned to 5 treatments with 6 replicates per treatment (5 pigs per pen). The treatments included: 1) CON: basal diet (corn-SBM based diet), 2) BB: basal diet + 4% barley bran, 3) OB: basal diet + 4% oat bran, 4) WB: basal diet + 4% wheat bran, 5) RB: basal diet + 4% rice bran. Notably, all fiber-supplemented groups exhibited significantly higher average daily gain and feed efficiency compared to the CON group ($p < 0.01$). Specifically, the BB group recorded the lowest fecal score during the early phase after weaning among all treatments ($p < 0.01$). Regarding blood profiles, pigs fed fiber sources maintained significantly higher red blood cell-related parameters in PhaseII compared to the CON group ($p < 0.01$). In conclusion, while various fiber sources provide benefits, the inclusion of barley bran is the most effective nutritional strategy to simultaneously enhance growth performance and reduce the incidence of diarrhea. The results of this study suggest that barley bran can be successfully incorporated into weaning pig diets to mitigate post-weaning diarrhea and optimize productivity.

Key words : various fiber sources, barley bran, growth performance, post-weaning diarrhea, weaning pigs

Eggshell quality in brown laying hens: formation, challenges, and nutritional strategies

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The eggshell serves as an essential protective barrier that determines egg quality during storage and transport. Eggshell integrity depends on complex formation processes involving protoporphyrin IX (PPIX) synthesis for pigmentation and calcium carbonate (CaCO_3) mineralization for structural strength and thickness. Hen age, environmental challenges, and nutritional deficiencies compromise these formation mechanisms. These factors impair calcium metabolism, disrupt acid-base balance, and elevate oxidative stress, ultimately resulting in weakened shell structure and compromised egg quality. Therefore, nutritional and physiological strategies are essential to restore disrupted formation pathways and optimize eggshell mineralization efficiency. Enhanced calcium utilization and strategic phytase supplementation improve mineral deposition and shell structural integrity. Gut microbiota modulation enhances calcium absorption by promoting short-chain fatty acid and lactic acid production. These metabolites lower intestinal pH and improve gut integrity, thereby facilitating mineral utilization and eggshell mineralization. Additionally, antioxidant interventions protect pigment synthesis pathways and maintain cellular homeostasis during shell formation. These approaches suggest synergistic effects in restoring eggshell quality parameters. Therefore, this review suggests that comprehensive restoration of shell formation requires integrated approaches that simultaneously modulate multiple physiological pathways.

Key words : calcium utilization, eggshell quality, gut health, laying hen, nutritional strategies, protoporphyrin IX

Interactive effects of *in ovo* β -hydroxy- β -methylbutyrate and different embryonic day on hatching performance and intestinal morphology in Japanese quail

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The objective of this study was to investigate the effects of *in ovo* feeding (IOF) of β -hydroxy- β -methylbutyrate (HMB) on hatching performance and jejunal morphology in Japanese quail. The present experiment was conducted using a 2×2 factorial arrangement including 2 IOF days (embryonic day 7 or 11; E7 or E11) and 2 IOF treatments ($1 \times$ PBS or 1% HMB), administered into the air cell at a volume of 50 μ L per egg. A total of 520 eggs from 16-week-old Japanese quail breeder flocks were allotted to 4 treatments with 10 replicates. Results indicated a significant interaction ($p < 0.05$) between IOF day and treatment for hatching performance. On E7, IOF of HMB showed greater ($p < 0.05$) body weight (BW), chick yield, and less ($p < 0.05$) hatch window than the IOF of PBS. On E11, IOF of HMB decreased ($p < 0.05$) pipped shell compared to IOF of PBS. For the main effect of IOF days, no significant effect of IOF day was observed on hatching performance and jejunal morphology. Regarding the main effect of IOF treatment, IOF of HMB increased ($p < 0.05$) hatch of set, hatch of fertile, BW, chick yield, villus height, villus width, and villus height to crypt depth ratio compared to IOF of PBS. IOF of HMB decreased ($p < 0.05$) hatch window and late embryo mortality compared to IOF of PBS. In conclusion, IOF of HMB on E7 resulted in effective hatching performance. Furthermore, HMB improved hatching performance and jejunal morphology, although its effects varied depending on the IOF day.

Key words : β -hydroxy- β -methylbutyrate, embryonic day, hatching performance, *in ovo* feeding, Japanese quail

Differential heat stress responses in chicken breast and leg muscle satellite cells: implications for oxidative stress and apoptosis

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Heat stress is a major environmental factor affecting poultry production, yet its cellular mechanisms in muscle satellite cells remain incompletely understood. This study investigated the time-dependent responses of chicken breast and leg muscle satellite cells to heat stress (43°C), focusing on oxidative stress, apoptosis, and mitochondrial adaptation. Cells were exposed to heat stress for 1, 6, and 24 h, and the expression of HSP60, HSP70, SOD1, IL6, BAX, BCL2, and PGC1 α was analyzed using RT-PCR. Heat stress rapidly induced heat shock protein expression in both cell types, with significantly greater upregulation of HSP60 and HSP70 in leg muscle cells at 1 h. Early increases in SOD1 and PGC1 α were observed only in leg muscle cells, indicating faster activation of oxidative and mitochondrial responses. At later time points, both cell types showed increased apoptosis-related gene expression; however, leg muscle cells exhibited a higher BAX/BCL2 ratio, suggesting greater susceptibility to apoptosis, whereas breast muscle cells maintained higher anti-apoptotic capacity. These findings suggest that leg muscle satellite cells respond more rapidly to heat stress but are more prone to oxidative damage and apoptosis, while breast muscle satellite cells exhibit delayed yet more protective adaptive responses. These differences may be associated with intrinsic muscle fiber characteristics and mitochondrial activity. This research was supported by Korea Institute of Planning and Evaluation for Technology in Food, Agriculture and Forestry (IPET) through the ‘High Value-added Food Technology Development Program’ and was funded by the Ministry of Agriculture, Food and Rural Affairs (MAFRA) (322006-05-CG000).

Key words : apoptosis, chicken satellite cells, heat stress, mitochondrial adaptation, oxidative stress

Analysis of key determinants and correlations of productivity in laying hens during the mid-laying period

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Laying hen productivity is determined by the complex interaction of management practices and environmental factors. The mid-laying period is a critical time for maintaining productivity and managing feed intake; therefore, elucidating the quantitative relationships among key factors is essential for developing effective management strategies. However, our understanding of the quantitative relationships among major productivity factors during the mid-laying period remains limited. This study collected weekly data on egg production, egg weight, feed intake, and temperature from laying hens aged 40–48 weeks. Based on this data, indicators such as Egg mass, Feed intake, Feed Conversion Ratio (FCR), and Temperature (Temp) were calculated to analyze the correlations among the variables. Pearson correlation analysis was used to evaluate the relationships among the variables, and statistical significance was tested at the 0.05 level. The results showed that Feed intake and Temp were significantly correlated with Egg mass ($r = 0.14$, $p < 0.05$; $r = 0.21$, $p < 0.001$), but the strength of these correlations was generally limited. In contrast, a strong negative correlation was observed between FCR and Egg mass ($r = -0.85$, $p < 0.001$), and regression analysis also showed high explanatory power ($R^2 = 0.72$). This suggests that FCR is a key indicator explaining mid-laying productivity. Therefore, it was confirmed that, to improve mid-lay productivity, a precise feeding management strategy based on FCR tailored to each age group is more important than simply increasing feed intake. However, as this study is based on mid-lay data, its application to the pre- and post-lay periods is limited, and further research reflecting the entire production cycle and various environmental conditions is needed.

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Key words : laying hens, feed conversion ratio, feed intake, egg mass, precision feeding

A comprehensive analysis of breed-associated predispositions in canine metabolic disorders

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With the expansion of the companion animal market, a wider variety of canine breeds are being raised, leading to an increased demand for customized healthcare. To effectively support this demand, identifying the most frequently associated metabolic disorders with breeds is essential. This study aimed to establish a frequency-based reference for metabolic disorders by investigating the distribution of 30 metabolic diseases reported across 64 canine breeds. Data regarding breed-disease associations were systematically collected and analyzed based on WSAVA guidelines and major academic databases, including PubMed and ScienceDirect. The analysis of reported cases revealed that hypothyroidism (21.9%) was the most prevalent metabolic disorder, followed by nephrolithiasis (14.1%), and both diabetes mellitus and hyperlipidemia (12.5% each). Regarding breed-specific vulnerabilities, the Doberman Pinscher (23.3%) exhibited the highest frequency of documented metabolic disease associations, followed by the Dachshund and German Shepherd (20.0% each). Additionally, the Labrador Retriever, Golden Retriever, Yorkshire Terrier, and West Highland White Terrier (16.7% each) showed identical frequencies of association. These findings highlight the associations between metabolic diseases and canine breeds, indicating differences in disease susceptibility across breeds. Accordingly, such patterns may be considered in the development of breed-specific, personalized health management strategies.

Key words : canine, canine metabolic diseases, breed susceptibility

산란계 복지 및 생산지표에 대한 환경 풍부화물 제공 효과와 영향 요인

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현재 국내외 동물복지 인증기준에서는 산란계의 행동 욕구 충족 및 복지 문제 경감의 수단으로 환경 풍부화물 제공을 권장하고 있다. 그러나 환경 풍부화물 제공 효과는 산란계의 유전적 특성 및 제공 조건에 따라 상이한 바, 일관되지 않은 연구 결과로 인해 과학적 근거에 기반한 적정 제공 기준을 수립하기 어려운 실정이다. 이에 본 고찰에서는 산란계에 헛대, 알팔파 및 부석을 제공한 총 28편의 연구 논문을 대상으로 그 효과와 영향 요인을 검토하여, 향후 산란계 환경 풍부화물 제공 기준 및 근거 마련을 위한 기초자료로 활용하고자 한다. 헛대 제공을 통해 산란계의 공포 반응 및 이상행동 감소, 인지능력 향상, 골밀도 및 근육량 증가 등 행동 및 근골격계 지표 개선이 보고되었으나, 생산성과 생리학적 지표에 대한 효과는 상대적으로 제한적인 것으로 나타났다. 알팔파와 부석은 대체로 산란계의 깃털 및 물체 찢기 감소, 스트레스 호르몬 감소 등 행동 및 생리학적 지표에 긍정적인 영향을 미쳤으나, 생산성과 깃털 상태에 대한 효과는 일관되지 않았다. 다만 일부 연구에서 알팔파와 부석을 함께 제공할 경우, 산란계의 피부와 깃털 상태가 개선되는 것으로 나타났다. 한편, 이들 효과는 제공 시기, 종류, 설치 형태 등 환경 풍부화물의 제공 조건을 비롯해 품종, 사육 조건 및 지표 측정 시점 등 다양한 요인의 영향을 받는 것으로 보인다. 본 고찰에서는 제공 조건 및 실험 설계의 이질성으로 인해 산란계 환경 풍부화물 제공 효과의 직접적인 비교에 한계가 있음을 확인하였다. 보다 효과적인 제공 기준 마련을 위해서는 연구 설계 및 평가 방법의 이질성을 줄이기 위한 지속적인 노력이 필요할 것으로 사료된다.

Key words : 산란계, 동물복지, 환경풍부화물, 헛대, 알팔파, 찢는 물질

Impact of dietary crude protein and fiber levels during the early weaning on growth performance, blood profiles, and fecal score in weaning pigs

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This study was conducted to evaluate the effects of dietary crude protein (CP) and fiber (barley bran, BB) levels on the growth performance, blood profiles, and fecal score of weaning pigs. A total of 180 weaning pigs (7.24 ± 0.155 kg) were assigned to 6 treatments with 6 replicates per treatment (5 pigs per pen). The treatments consisted of: 1) PC: 18% CP + 2,000 ppm ZnO, 2) NC: 18% CP, and 3–6) T1–T4, which received different CP and BB levels (18% or 16% CP; 0% or 4% BB) only during PhaseI, followed by a common diet (18% CP + 4% BB) in PhaseII. Notably, the overall gain-to-feed ratio was significantly higher in T1 (18% CP + 0% BB) than in the PC and NC groups (ANOVA, $p = 0.032$), showing optimized feed efficiency. In blood profiles, a significant CP $\times$ BB interaction was observed for lymphocyte counts during PhaseI (CP $\times$ BB, $p = 0.008$). Regarding fecal score, while the PC group showed the lowest score, lowering the dietary CP level from 18% to 16% significantly reduced fecal score (CP, $p = 0.009$), effectively mitigating post-weaning diarrhea. In conclusion, while growth performance was maintained across treatments, providing 18% CP without barley bran in the immediate post-weaning phase maximized feed efficiency. Furthermore, reducing the dietary CP level to 16% served as an effective nutritional strategy to mitigate post-weaning diarrhea in weaning pigs.

Key words : crude protein levels, barley bran, growth performance, fecal score, weaning pigs

Comparative effects of different dietary fiber sources on ileal and colonic health: Insights into gut integrity and microbial interactions in weaning pigs

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This study aimed to investigate the effects of different dietary fiber sources on intestinal morphology, mRNA expression of genes related to gut integrity, and microbial composition of weaning pigs. A total of 60 weaning pigs (age 28 d, initial body weight 7.64 ± 0.365 kg, $n = 6$) were assigned to 5 treatments: 1) CON: corn-SBM based diet, 2) BB: basal diet + 4% barley bran, 3) OB: basal diet + 4% oat bran, 4) WB: basal diet + 4% wheat bran, and 5) RB: basal diet + 4% rice bran. Thirty pigs were euthanized at the end of PhaseI and PhaseII, respectively. The results showed that dietary fiber supplementation, particularly BB and WB, significantly increased large intestinal crypt depth and total goblet cells during PhaseII compared to the CON group ($p < 0.05$). In the ileum, the mRNA expression of *ZO-1* was significantly upregulated in the BB group during PhaseI ($p < 0.01$), although *MUC2* expression was lower in all fiber-supplemented groups than in the CON group ($p < 0.01$). The expression of *Ki-67*, a cell proliferation marker, was significantly higher in all fiber groups than in the CON group ($p < 0.01$), whereas *ODC1* expression was significantly downregulated by fiber supplementation ($p < 0.01$). Regarding immune response, BB group tended to lower the mRNA expression of *CD8* in PhaseII ($p = 0.015$). According to LEfSe analysis, BB supplementation specifically enriched beneficial biomarkers, including *Butyrivibrionaceae* and *Prevotellaceae* in the cecum, as well as *Faecalibacterium* in the feces. In conclusion, barley bran is the most effective strategy to improve intestinal structures and promote a favorable microbial environment by modulating gut barrier-related genes in weaning pigs.

Key words : dietary fiber sources, intestinal morphology, tight junction proteins, gut microbiome, weaning pigs

Effects of dietary calcium and phosphorus supply levels based on total versus standardized ileal digestible specifications on growth performance of broiler chickens

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The present study was conducted to evaluate the effects of dietary calcium (Ca) and phosphorus (P) levels on growth performance of broiler chickens, comparing diets formulated based on total Ca and non-phytate phosphorus (NPP) versus standardized ileal digestible (SID) Ca and P. A total of 210 10 day-old birds were allocated to five dietary treatments with six replicate cages of seven birds per cage in a randomized complete block design based on body weight. Treatments consisted of 1) CON1, formulated based on SID Ca and P, 2) CON2, formulated based on total Ca and NPP, 3–4) LOW1 and LOW2 reducing Ca and P levels of CON1 and CON2 by 30%, respectively, and 5) HIGH, increasing SID Ca and P of CON1 by 30%. On day 14, body weight and feed leftovers were recorded to calculate body weight gain, feed intake, gain-to-feed ratio. Data were analyzed using the MIXED procedure of SAS software 9.4, and the experimental unit was the cage. Birds fed diets formulated on a total Ca and NPP basis (CON2 and LOW2) exhibited superior growth performance compared to those fed SID-based diets ($p < 0.001$). In conclusion, these findings indicate that the nutrient specification system significantly affects broiler growth performance. Furthermore, the observed performance differences between total and SID-based formulations suggest that further research is needed to precisely determine the optimal Ca and P inclusion levels under each specification system.

Key words : broiler, calcium, growth performance, nutrient specification, phosphorus

Evaluation of antioxidant activity of ergothioneine using a co-culture microfluidic chip with canine skeletal muscle and liver cells

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Co-culture microfluidic chip systems are *in vitro* platforms that integrate multiple cell types within a controlled microfluidic environment, enabling dynamic inter-organ interactions. Ergothioneine (EG) is a naturally occurring thiol-histidine betaine found in foods, particularly mushrooms, and functions as an antioxidant by scavenging reactive oxygen species (ROS). In this study, the antioxidant activity of EG was evaluated using a co-culture microfluidic chip integrating canine skeletal muscle and liver cells. Oxidative stress was induced by hydrogen peroxide via the inlet, while EG was administered through the outlet. After 24 h, cells were collected for mRNA expression analysis. Compared with the oxidative stress-induced control, EG treatment altered the expression of genes related to antioxidant defense, apoptosis, and inflammatory responses, suggesting enhanced cellular defense against oxidative stress. In conclusion, EG exerted protective effects by regulating gene expression associated with oxidative stress responses. These results demonstrate the utility of the co-culture microfluidic chip system for evaluating bioactive compounds.

Key words : antioxidant, canine liver cell, canine muscle cell, co-culture chip, ergothioneine

In vitro digestibility of cat diets varying in carbohydrate source

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Carbohydrate sources are widely used as ingredients in cat diets; however, their digestibility varies depending on starch structure and fiber composition. Although *in vivo* trials are considered the gold standard, ethical and practical limitations have increased the need for reproducible *in vitro* methods. This study evaluated the *in vitro* dry matter (DM) and crude protein (CP) digestibility of cat diets containing six carbohydrate sources: rice, corn, potato, tapioca, sweet potato, and wheat. All diets met the nutrient requirements for adult cats based on AAFCO guidelines. *In vitro* digestion was performed using a two-step enzymatic model simulating gastric and intestinal phases. Digestibility was calculated according to Biagi et al. (2016) as follows: DM (%) = 100 – (residue weight / sample weight × 100); CP (%) = 100 – [(CP % in residue × (100 – DM digestibility %)) / CP % in diet]. Potato- and tapioca-based diets showed significantly higher ($p < 0.05$) DM and CP digestibility than corn-, sweet potato-, and wheat-based diets. These findings provide reference data for selecting carbohydrate sources in nutritionally optimized cat diets.

Key words : cat, carbohydrate source, *in vitro* digestibility

Arginine supplementation enhances intestinal barrier integrity via jejunal microbiota modulation in broiler chickens raised under multiple stress conditions

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This study aimed to investigate the effects of dietary concentrations of arginine (Arg) on jejunal microbiota composition and predicted functional profiles in broiler chickens raised under multiple stress (MS) conditions. A total of 2,052 21-d-old Ross 308 broiler chickens were randomly allotted to 6 treatments with 6 replicates in a 2 × 3 factorial arrangement. Birds were raised under normal (N) conditions (23.0 ± 0.7°C; 9 birds/m²) and MS conditions (29.9 ± 0.7°C for 10 h and 23.1 ± 0.9°C for 14 h; 18 birds/m²). The experimental diets were prepared with digestible Arg levels of 1.17, 1.35, and 1.52%. Treatment groups were named as N-1.17%, N-1.35%, N-1.52%, MS-1.17%, MS-1.35%, MS-1.52%. Four samples per treatment group were included in the microbial analysis. Results indicated that Pielou's evenness was less ($p < 0.05$) in MS-1.35% and MS-1.52% groups than in N-1.17%, N-1.35%, and MS-1.17% groups. At the genus level, *Ligilactobacillus* was the most abundant, followed by *Campylobacter*, *Staphylococcus*, and *Enterococcus*. Arg-related metabolic pathways were increased under MS conditions at 1.35% and 1.52% Arg groups. *Ligilactobacillus* was the largest contributor to multiple KEGG Orthologs (KOs) enriched in 1.52% Arg groups compared with 1.17% Arg groups. Arg deiminase pathway-related KOs showed the same directional correlations ($p < 0.05$) and increased with dietary Arg levels. In conclusion, increasing dietary Arg levels enhances *Ligilactobacillus*-associated functions and Arg-related metabolic pathways in broiler chickens raised under MS conditions.

Key words : arginine, broiler chicken, gut microbiota, multiple stress, predicted functional profile

Nutritional composition and antioxidant properties of young alfalfa as a functional feed additive for dogs

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Plant-based functional ingredients for canine diets require comprehensive evaluation of their nutritional and antioxidant properties. Accordingly, this study evaluated the nutritional composition and antioxidant activity of hydroponically grown, dried young alfalfa powder. Proximate composition analysis revealed a high protein content (41.89%; 45.70% on a dry matter basis), along with moderate fiber (11.05%) and low fat (1.77%). The powder demonstrated a robust amino acid profile, particularly rich in aspartic acid (8.99%) and key essential amino acids, including leucine (1.81%), lysine (1.78%), and valine (1.31%), supporting its value as a high-quality plant-based protein source. Antioxidant assays showed a total phenolic content of 9.30 ± 0.09 mg GAE/g and a total flavonoid content of 5.48 ± 0.96 mg QE/g. Furthermore, the extract exhibited strong, concentration-dependent ABTS radical scavenging activity, reaching $86.42 \pm 0.88\%$ at 10 mg/mL (444.86 μ M AAE). These findings indicate that young alfalfa powder is a potent source of essential nutrients and natural antioxidants, with significant potential as a multifunctional ingredient to enhance the nutritional value and metabolic health of canine diets.

Key words : alfalfa, antioxidant activity, functional feed additive, dog, nutritional composition

Effects of dietary supplementation with *Gloiopeltis tenax* on gut microbiota composition and functional profiles in dogs

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Dietary components play a key role in modulating gut microbiota and are increasingly considered in the development of functional feed ingredients for companion animals. This study investigated the effects of dietary supplementation with *Gloiopeltis tenax* on gut microbial composition and predicted functional profiles in dogs. Ten adult dogs (Maltese and Poodle) were fed a diet containing 1% *G. tenax* for 4 weeks following AAFCO guidelines. Gut microbiota was analyzed using 16S rRNA gene sequencing, and functional potential was predicted using PICRUST2. *G. tenax* supplementation significantly altered gut microbial community structure (beta diversity), with notable changes in genera associated with polysaccharide degradation. Functional prediction analysis indicated shifts in pathways related to glycan degradation and carbohydrate metabolism. These results suggest that *G. tenax* supplementation modulates gut microbiota and metabolic potential in dogs, providing foundational evidence for its application as a functional feed ingredient.

Key words : *Gloiopeltis tenax*, dog, gut microbiome, 16S rRNA, sequencing, functional feed ingredient

Contribution of compromised feed intake and feed efficiency to growth reduction in nursery pigs challenged with F18⁺ *E. coli*

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The first objective of this study was to quantify how much F18⁺ *E. coli* challenge reduces growth performance in nursery pigs based on meta-analysis. The second objective was to quantify how much of the reduction in weight gain in nursery pigs challenged with F18⁺ *E. coli* could be explained by the reduction in feed intake and feed efficiency. Data were collected from 23 peer-reviewed papers in which nursery pigs were challenged with F18⁺ *E. coli*. Percent changes (%) in average daily gain (ADG), average daily feed intake (ADFI), and gain-to-feed ratio (G:F) of F18⁺ *E. coli*-challenged nursery pigs, relative to non-challenged pigs, were defined as Δ ADG, Δ ADFI, and Δ G:F, respectively. The PROC MIXED of SAS was used to compare ADG, ADFI, and G:F between non-challenged and F18⁺ *E. coli*-challenged nursery pigs with F18⁺ *E. coli* challenge as a fixed effect and paper (individual study) as a random effect. The PROC REG of SAS was used to regress Δ ADG on Δ ADFI or Δ G:F. The ADG (444 vs. 368), ADFI (689 vs. 614), and G:F (0.676 vs. 0.615) of non-challenged pigs were greater ($p < 0.05$) compared with pigs challenged with F18⁺ *E. coli*. Regression lines for Δ ADG were generated as follows: Δ ADG = $7.40 + 0.89 \times \Delta$ ADFI ($R^2 = 0.54$) and Δ ADG = $11.72 + 0.71 \times \Delta$ G:F ($R^2 = 0.41$). In conclusion, F18⁺ *E. coli* challenge reduces ADG, ADFI, and G:F by an average of 17%, 11%, and 9%, respectively, and the reduction in ADG by F18⁺ *E. coli* challenge can be attributed 54% to compromised ADFI and 41% to compromised G:F.

Key words : F18⁺ *E. coli*, feed efficiency, feed intake, nursery pigs, weight gain

Comparison of nutritional characteristics of protein hydrolysates derived from different sources and evaluation of *in vitro* ileal digestibility in dog diets

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As the pet food market grows, interest in protein hydrolysates has increased, yet comparative studies on hydrolysates derived from different source materials remain limited. This study compared the nutritional characteristics of commercially available protein hydrolysates from plant (soybean meal, HSM), insect (mealworm, HMW), and marine (shrimp, HSP) sources, and evaluated the *in vitro* ileal digestibility (IVID) of commercial dog diets formulated with each hydrolysate as the primary protein source: soybean meal hydrolysate diet (HSMD), mealworm hydrolysate diet (HMWD), and shrimp hydrolysate diet (HSPD). Crude protein content was similarly high in HMW (72.18%) and HSP (72.50%), while HSM (54.60%) was significantly lower ($p < 0.05$). Ether extract and crude fiber contents were highest in HMW ($p < 0.05$). Regarding essential amino acid (EAA) composition, HSP showed the highest total EAA content ($p < 0.05$). The NPN-to-CP ratio was highest in HSP (93.47%), and free amino group content was also highest in HSP (24.27 g/100 g DM), indicating the greatest degree of hydrolysis among the three hydrolysates. In the diet, total EAA content was highest in HSMD, though *in vitro* crude protein digestibility was highest in HSPD (93.47%), followed by HSMD (90.19%) and HMWD (88.41%), and HSPD also showed the highest digestibility across all essential amino acids ($p < 0.05$). These findings suggest that protein source and processing characteristics should be considered in the selection of hydrolysate ingredients for dog diet formulation.

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Key words : dog diet, *in vitro* ileal digestibility, protein hydrolysate, protein source

Effects of breed-specific feeding programs on growth performance of Hy-Line Brown and Lohmann Brown-Lite pullets

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This study evaluated the effects of breed-specific feeding programs on growth performance, nutrient digestibility, fecal characteristics, and manure gas emissions in Hy-Line Brown and Lohmann Brown-Lite pullets during the growing phase. A total of 600 one-day-old pullets were assigned to four dietary treatments for 16 weeks in a completely randomized design. The treatments included conventional and transition feeding programs based on the Daehan Feed Series (Daehan Feed Co., Ltd., Incheon, Republic of Korea). Overall growth performance, nutrient digestibility, fecal score, and ammonia emission were not significantly different among treatments ($p > 0.05$). However, transition feeding programs showed numerical improvements in final body weight and feed conversion ratio, particularly in Lohmann Brown-Lite pullets compared to Hy-Line Brown. In addition, the phase-adjusted feeding strategy maintained stable fecal scores, which was associated with a numerical reduction in ammonia emissions. In conclusion, breed-specific transition feeding programs may contribute to improved growth performance and environmental conditions by supporting gut stability and reducing ammonia emissions, suggesting potential benefits for pullet welfare and productivity.

Key words : ammonia emission, fecal score, growth performance, laying hens, phase feeding, pullet

상업농장 현장 비교를 통한 이유자돈 사료내 감미제 급여의 생산성 개선 가능성 평가

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본 연구는 양돈농장의 생산성 향상을 목적으로 감미제 급여가 이유 후 돼지의 성장 및 출하일령에 미치는 영향을 상업농장 조건에서 평가하고자 수행되었다. 1차 평가는 2023년 9월부터 12월까지 용인지역 비육농장 1,000두를 대상으로 실시하였으며, A동 340두에는 감미제를 급여하고 B동 660두는 비급여 비교구로 설정하였다. 감미제 급여구는 비교구에 비해 출하종료일이 10일 단축되었고 폐사율은 1.5% 감소하였다. 2차 평가는 2025년 3월부터 9월까지 논산지역 명현농장 이유자돈 600두를 대상으로 실시하였으며, 이유 후 20일간 감미제를 급여한 후 80일령 전출체중을 측정하고 동일 농장의 2024년 기록과 비교하였다. 2025년 급여군의 80일령 전출체중은 전년 대비 3.5 kg 증가하였다. 결론적으로, 감미제의 초기 급여는 상업농장 조건에서 이유 후 성장 개선, 폐사율 감소 및 출하일령 단축에 긍정적 가능성을 보였다. 다만 본 결과는 일반 사육농장에서 수행된 현장 비교 자료이므로, 효과의 명확한 검증을 위해서는 추가적인 통제실험이 필요하다.

Key words : 감미제, 이유자돈, 성장성적, 폐사율, 출하일령

Effects of dietary amino acids and chromium picolinate supplementation on growth performance and meat characteristics in Woori Heukdon pigs

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This study evaluated the effects of phase-specific dietary supplementation with amino acids and chromium picolinate on growth performance, nutrient digestibility, and meat characteristics in Woori Heukdon (WHD) pigs. A total of 104 WHD pigs (initial body weight, 31.5 ± 0.24 kg; 40 gilts and 64 barrows) were assigned to either a control diet or a treatment diet containing 4% higher amino acid levels during the growing period and 400 ppb chromium picolinate during the finishing period. Growth performance, backfat thickness, and nutrient digestibility were assessed throughout the feeding trial, and meat proximate composition was analyzed in 20 pigs per treatment after slaughter. Dietary supplementation did not significantly affect body weight, backfat thickness, or nutrient digestibility. However, average daily feed intake increased in the treatment group during the growing and overall periods, with a concomitant decrease in feed efficiency during the growing period ($p < 0.05$). Regarding meat proximate composition, the treatment group showed higher fat and lower protein contents in the loin and ham, whereas the belly showed lower fat and higher moisture contents ($p < 0.05$). Overall, phase-specific supplementation with amino acids and chromium picolinate had limited effects on growth performance and nutrient digestibility but altered meat compositional characteristics in WHD pigs.

Key words: Woori Heukdon, amino acids, chromium picolinate, growth performance, meat characteristics

Behavioural and affective responses of heat-stressed weaned pigs supplemented with anandamide or citric acid

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Heat stress during post-weaning alters behavioural responses and may impair adaptation in pigs. This study evaluated whether dietary anandamide (AEA) or citric acid (CA) influence behavioural and affective responses in weaned pigs exposed to heat stress. A total of 600 weaned piglets were randomly allocated to four dietary treatments: NC, A1 (1,000 ppm AEA), A2 (2,000 ppm AEA), and CA (2,000 ppm CA). Behavioural responses were evaluated using the novel object test (NOT), human-animal relationship test (HART), forced human approach test (FHAT), and voluntary human approach test (VHAT), while affective state was assessed using qualitative behaviour assessment (QBA). A1 pigs showed higher HART scores than those in the other groups on day 2 ($p < 0.05$). No significant differences were detected for NOT latency, VHAT, or FHAT. QBA revealed a temporal shift across all groups from a more tense/fearful state at day 0 to a calmer state from day 2 onward. Behavioural tests and QBA provided complementary measures for evaluating heat stress adaptation in weaned pigs. While AEA supplementation was associated with transient alterations in early behavioural responses, QBA revealed a consistent time-dependent shift toward a calmer affective state following weaning across all treatments.

Key words : behavioural response tests, thermal stress, weaned piglets, qualitative behaviour assessment, stress response

Dietary coated omega-3 supplementation modifies egg fatty acid profile without impairing performance or egg quality in late-phase Hy-Line Brown laying hens

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This study evaluated the effects of dietary coated omega-3 (REI3) supplementation on productive performance, egg quality, blood profile, and nutrient digestibility in late-phase laying hens. A total of 96 Hyline Brown laying hens at 70 weeks of age were randomly assigned to four dietary treatments, including six replicates with four hens in each for 15 weeks fed: CON, basal diet; TRT1, basal diet + 0.1% REI3; TRT2, basal diet + 0.2% REI3; and TRT3, basal diet + 0.3% REI3. The data were subjected to statistical analysis using version SAS 9.4 (SAS Institute Inc., Cary, NC, USA) based on a completely randomized design with four dietary treatments. Productive performance, egg quality, egg yolk fatty acid composition, blood profile and nutrient digestibility were analyzed by one-way ANOVA. Linear and quadratic effects of increasing dietary coated omega-3 levels were assessed using orthogonal polynomial contrasts. $p < 0.05$ was set as significant. Dietary coated omega-3 supplementation did not significantly affect body weight, downgraded egg percentage, feed conversion ratio, average daily feed intake, egg quality traits, or nutrient digestibility. Blood total cholesterol, LDL, white blood cell count, and lymphocyte percentage were also not significantly altered. However, hens fed 0.2% and 0.3% REI3 showed numerically higher egg production and lower FCR during the late phase of the trial. In addition, serum triglyceride concentration showed a linear tendency to decrease ($p = 0.0671$), whereas HDL showed a linear tendency to increase ($p = 0.0520$) with increasing REI3 levels. In conclusion, moderate coated omega-3 supplementation had limited effects on performance-related traits but effectively enhanced the nutritional quality of egg lipids in aging hens.

Key words : coated omega-3, Hyline Brown laying hens, late laying period, egg quality, blood lipid profile, nutrient digestibility.

Dietary glycozyme supplementation enhances reproductive performance in sows and pre-weaning growth in piglets

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The reproductive performance of lactating sows is critical for swine productivity, but reduced feed intake during lactation can lead to energy imbalance, impairing sow health and piglet growth. Glycozyme, a mixture of simple sugar, β -glucan, exogenous enzymes, and probiotics, has been developed as a potential antibiotic alternative to enhance immune function and nutrient utilization. This study was conducted to evaluate the effects of Glycozyme supplementation on reproductive performance, nutrient digestibility, milk composition, and blood profiles of lactating sows, as well as growth and health status of their suckling piglets. A total of 21 lactating sows (Landrace $\times$ Yorkshire; average parity of 3.3) were randomly assigned to one of three dietary treatments for a 5-week trial, with seven replicates per treatment and one sow per replicate. The dietary treatments consisted of: 1) CON (basal diet), 2) TRT1 (basal diet + 0.25% Glycozyme), and 3) TRT2 (basal diet + 0.50% Glycozyme). Data were analyzed using the General Linear Model procedure of SAS (2013), and means were compared via Duncan's multiple range test. Linear and quadratic effects of Glycozyme levels were also evaluated. Statistical significance was declared at $p < 0.05$. In lactating sows, average daily feed intake (ADFI), milk yield, milk composition (protein, lactose, and solids-not-fat), and serum glucose levels were significantly higher in TRT2 than in CON ($p < 0.05$). Conversely, blood cortisol levels were significantly higher in CON than in TRT2 ($p < 0.05$). However, no significant differences were observed in nutrient digestibility and skin color among the dietary treatments ($p > 0.05$). Similarly, in suckling piglets, body weight and average daily gain were significantly higher in TRT2 than in CON ($p < 0.05$). In contrast, parameters such as fecal score, skin color, and blood profiles in piglets did not show any treatment-related deviations. In conclusion, dietary supplementation with Glycozyme, particularly at 0.50%, improved reproductive performance, milk production, and metabolic status in lactating sows, which subsequently enhanced the growth performance of suckling piglets without negatively affecting health-related parameters. These results suggest that Glycozyme can be used as a functional feed additive to improve both sow productivity and piglet growth during lactation.

Key words : glycozyme, growth performance, lactating sows, reproductive performance, suckling piglets

Variation in social interaction following regrouping is associated with neuromodulation-related gut microbial functions in growing pigs

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Social interaction is essential for pigs to form structured group relationships and establish dominance hierarchies. In commercial farms, however, pigs have limited early-life social experiences and are abruptly regrouped into unfamiliar social groups, resulting in social instability, prolonged aggression and physiological stress. Given the emerging role of the gut microbiome in modulating behavioural regulation, this study investigated gut microbial functional profiles associated with variation in social interaction following regrouping. After a 2-h transport period and subsequent random regrouping, a total of 319 pigs were allocated to six pens across two batches. Based on the total proportion of pigs engaged in affiliative and agonistic interactions during the 24 h post-regrouping period, pens were classified into low social interaction (LS, $n = 9$) and high social interaction (HS, $n = 9$) groups. Faecal samples collected on days 1–2 post-regrouping were analysed using 16S rRNA sequencing to determine microbial composition and predicted functions. In LS pigs, taxa such as *Terrisporobacter* were positively correlated with functions related to excitatory neuromodulation ($r = 0.50$ to 0.60 , $p < 0.01$), whereas HS-associated taxa such as *Lactobacillus* were negatively correlated with these functions ($r = -0.74$ to -0.62 , $p < 0.001$). Conversely, HS-associated taxa, including *Treponema*, were positively correlated with functions related to inhibitory neurotransmission ($r = 0.43$ to 0.50 , $p < 0.01$), while LS-associated taxa such as *Faecalibacterium* showed negative correlations ($r = -0.66$ to -0.51 , $p < 0.01$). Consistently, pro-inflammatory taxa and excitatory neuromodulation-related functions were more abundant in LS pigs, whereas anti-inflammatory taxa and inhibitory neuromodulation-related functions were more abundant in HS pigs. These findings suggest that variation in social interaction following regrouping is associated with distinct gut microbiota–function profiles, with directional divergence in relationships between taxa and functions, particularly in relation to neuromodulation. These patterns support a potential role of the gut microbiome in behavioural adaptation to social stress.

Key words : gut microbiota-brain axis, microbial metabolism, neurotransmission, social behaviour, social stress

Dietary microbial bioactive complex improves feed efficiency by modulating gut microbial fermentation in weaned piglets

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Improving feed efficiency while maintaining gut stability is a key nutritional objective during the post-weaning period in piglets. This study investigated the effects of dietary supplementation with a microbial bioactive complex (MBC), composed of *Pediococcus pentosaceus* CACC616, *Lactobacillus reuteri* CACC607, *L. dextrinicus* CACC889, *L. pentosus* CACC891, and *Saccharomyces cerevisiae* CACC699, on feed efficiency and gut microbial fermentation in weaned piglets. The complex was produced via solid-state fermentation (SSF), enabling the co-delivery of viable microorganisms and fermentation-derived metabolites. A total of 34 piglets were randomly assigned to either a basal diet (control) or the same diet supplemented with MBC for 33 days. The MBC contained approximately 2.4×10^9 CFU/g of lactic acid bacteria and 5.17×10^6 CFU/g of yeast and was included in the diet at 0.5%. MBC supplementation significantly improved feed conversion ratio ($p < 0.05$) and reduced average daily feed intake, indicating enhanced feed utilization efficiency without adverse effects on health-related blood parameters. The constituent strains exhibited acceptable safety characteristics, including the absence of hemolytic activity and low biogenic amine production. Microbial analysis revealed that taxa enriched in the MBC-treated group, including *Succinivibrio* and *Succinivibrionaceae* UCG-001, are associated with carbohydrate fermentation and succinate-producing pathways. Collectively, these findings demonstrate that dietary inclusion of MBC improves feed efficiency and reshapes gut microbial fermentation by modulating fermentation-associated metabolic pathways in weaned piglets, supporting its potential application as a functional feed additive in swine production.

Key words : microbial bioactive complex, weaned piglets, feed efficiency, feed conversion ratio, gut microbiota, propionate

Growth performance and fecal characteristics of growing-finishing pigs fed a DDGS-palm kernel meal-based diet in mash or crumble form

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Feed formulation remains one of the major determinants of profitability and sustainability in pig production, as feed accounts for the largest share of total production costs. Therefore, increasing attention has been directed toward reducing reliance on conventional protein sources through the inclusion of lower-cost agro-industrial co-products without impairing growth performance or carcass quality. This study aims to evaluate the effects of partial replacement of soybean meal (SBM) with palm kernel meal (PKM) and distillers dried grains with soluble (DDGS), offered in mash or crumble feed forms, on growth performance and fecal characteristics of growing-finishing pigs. A total of 210 growing pigs ([Landrace × Yorkshire] × Duroc), weighted 30 ± 3.5 kg, were placed into three dietary treatments with fourteen replicates and five animals in each pen and fed TRT1, a mash diet based on corn-SBM; TRT2, a mash diet based on corn-SBM-DDGS-PKM; and TRT3, a crumble diet based on corn-SBM-DDGS-PKM. Data was analyzed using SAS 9.4 (SAS Institute Inc., Cary, NC, USA). Body weight, fecal moisture, and fecal score were analyzed using repeated-measures mixed model with treatment, time, and treatment × time as fixed effects. ADG, ADFI, and FCR were analyzed using PROC MIXED. Growth performance was evaluated during the growing and finishing periods. Moreover, fecal score and fecal moisture were recorded as indicators of digestive stability. The results showed that during the growing phase, body weight, average daily gain, average daily feed intake, and feed conversion ratio did not differ significantly among mash or crumble treatments. Likewise, no significant treatment effects were observed on fecal score or fecal moisture in mash or crumble treatments. Similar results were obtained during the finishing phase, where growth performance parameters remained unaffected significantly by treatment under mash or crumble form, and fecal traits also showed no significant differences. These results indicated that PKM and DDGS can partially replace SBM in growing-finishing pig diets without detrimental effects on growth performance or fecal consistency under the present conditions. The findings also suggest that crumble feed did not confer a clear advantage over mash feed when used in PKM- and DDGS-containing diets.

Key words : growing-finishing pigs, palm kernel meal, DDGS, crumble, mash, fecal characteristics

Evaluation of ileal amino acid digestibility in bakery and biscuit by-products fed to growing pigs

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Rising feed costs and increasing sustainability demands driven with climate change have intensified interest in identifying alternative feed ingredients to replace corn as the primary energy source in swine diets. In particular, the reutilization of food by-products as feed ingredients has gained considerable attention as part of circular feed resource utilization strategies. Bakery and biscuit by-products are considered promising alternatives to corn due to their high energy density and palatability. However, their practical application is limited by variation in nutrient composition, highlighting the need for evaluation based on standardized ileal digestibility (SID) for precise diet formulation. Thus, this study was conducted to evaluate the apparent ileal digestibility (AID) and SID of amino acids in bakery by-products, including plain bread meal (PBM) and sweet bread meal (SBM), as well as biscuit meal (BM), and to compare these values with those of corn in growing pigs. A total of five barrows ([Landrace × Yorkshire] × Duroc) with an initial body weight of 17.22 ± 1.17 kg were assigned to a 5×5 Latin square design. Experimental diets consisted of a corn-based control diet (CON), diets containing the PBM, SBM, or BM, and a nitrogen-free diet used to estimate basal endogenous amino acid losses. All pigs were surgically fitted with a T-cannula at the distal ileum, and ileal digesta were collected for 2 days via the cannula. The SID of most indispensable amino acids in the PBM, SBM and BM did not differ from those in corn. These findings indicate that bakery and biscuit by-products may serve as an alternative feed ingredient in pig diets based on comparing SID basis.

Key words : ileal digestibility, bakery meal, biscuit meal, pigs

Effect of *Agastache rugosa* Kuntze (Korean mint) extract supplementation on growth performance, nutrient digestibility, blood profile in beagles

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Agastache rugosa Kuntze, commonly known as Korean mint, is a medicinal and functional herb widely cultivated in Northeast Asian countries, including Korea, Japan, and China. Earlier studies reported its various pharmacological activities, including antifungal, antiviral, anti-inflammatory, and antioxidant effects. However, its potential role in modulating the immune system in dogs has not yet been investigated. Therefore, this study aimed to evaluate the effects of dietary supplementation with *Agastache rugosa* extract on growth performance, nutrient digestibility, fecal microbiota, and blood profiles in beagles. Eight healthy beagles with an initial body weight of 12.47 ± 0.05 kg were enrolled in a 10-week crossover study consisting of two experimental phases: Phase 1 (weeks 0–4) and Phase 2 (weeks 6–10), separated by a 2-week washout period. Dogs were assigned to receive either a control (CON) commercial diet or the CON diet supplemented with *Agastache rugosa* Kuntze extract at a dose of 120 mg/day. Growth performance, blood profiles, nutrient digestibility, fecal moisture and pH, and fecal microbiota were assessed at the end of each phase. Data was analyzed using linear mixed models for growth performance, nutrient digestibility, fecal pH, and hematological parameters, with dietary treatment and experimental period as fixed effects and individual dogs as a random effect using SPSS version 22.0 (SPSS Inc., Chicago, IL, USA). Our results showed that inclusion of 120mg/day plant extract into beagles' diet had no significant effects either on growth performance, nutrient digestibility, or overall fecal microbiota composition; however, significantly ($p < 0.05$) increased immunoglobulin G and lymphocyte concentrations compared with the CON group. Based on these results, dietary supplementation with *Agastache rugosa* extract at 120 mg/day may enhance immune responses in beagles without adversely affecting growth performance, nutrient utilization, or gut microbial balance, indicating its potential as a functional feed additive for canine health.

Key words : probiotic, growth performance, nutrient digestibility, gut health

Optimization of phase-feeding programs to improve pork belly thickness in growing-finishing pigs

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The growing-finishing phase accounts for 80% of total feed consumption, where inappropriate protein levels often lead to excessive fat deposition and environmental pollution. Recently, low-crude protein (CP) diets supplemented with essential amino acids have emerged as a strategy to improve nitrogen utilization and gut health. Particularly in Korea, managing pork belly quality by controlling intermuscular fat is economically crucial. Therefore, this study evaluated the effects of phase-feeding programs using low-CP diets on growth performance, nutrient digestibility, fecal gas emissions, fecal score, meat quality, and carcass traits in growing-finishing pigs. A total of 200 growing pigs (initial body weight: 25.10 ± 1.76 kg) were randomly assigned to four dietary treatments for a 16 week trial: TRT1, growing diet (G, 4 wk) → early finishing diet (EF, 8 wk) → late finishing diet (LF, 4 wk); TRT2, G (4 wk) → EF (12 wk); TRT3, G (4 wk) → EF (8 wk) → G (4 wk); and TRT4, G (16 wk). For statistical analysis, all data were analyzed using the General Linear Model (GLM) procedure of SAS (2013). The significant differences among treatment means were determined by Duncan's multiple range test. No significant differences ($p > 0.05$) were detected between the treatment groups across all parameters, such as growth performance, nutrient digestibility, fecal gas emissions, fecal score, or meat quality. However, carcass traits analysis revealed that backfat thickness was significantly lower in TRT1 compared to TRT4 ($p < 0.05$). Furthermore, TRT4 resulted in a significantly higher fat proportion in the pork belly, particularly in the posterior rib region, whereas TRT1 exhibited the lowest fat proportion ($p < 0.05$). These findings demonstrate that phase-feeding programs using low-CP diets can successfully reduce dietary protein intake without compromising growth performance, nutrient utilization, or overall meat quality. Moreover, these programs effectively modulate fat deposition, offering a strategic approach to achieving desirable carcass characteristics in growing-finishing pigs.

Key words : growth performance, growing-finishing pig, low-crude protein diet, phase-feeding programs, pork belly

Establishment of a meta-regression approach for predicting performance model in pigs

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This study was conducted to develop and validate a meta-regression-based predictive model for growth performance in grower–finisher pigs by integrating nutritional, environmental, and management factors. Correlation analysis revealed that ADG was strongly associated with BW ($r = 0.75$), CP ($r = 0.55$), and key essential amino acids, particularly Thr, Trp, and Val ($r = 0.60$). In addition, AA ratios, including Lys:Thr, Lys:Trp, and Lys:Met, showed significant correlations with both ADG ($r = 0.30$) and FCR ($r = 0.55$), while environmental factors such as TEMP ($r = -0.30$) and DEN ($r = -0.50$) were negatively correlated with growth performance.

Key words : swine, meta-regression approach, performance prediction, phase feeding, low protein, nitrogen

Evaluation of nutrient and amino acid digestibility by age group in small-breed dogs: maltese and poodles

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This study evaluated life stage-dependent differences in nutrient and amino acid utilization in two representative dog breeds in Korea, Maltese and Poodles. Current data on nutrient requirements and digestibility in dogs are largely based on medium- and large-sized breeds, resulting in limited information for small-breed dogs. In this study, dogs were classified into puppies, adults, and seniors, and the apparent total tract digestibility (ATTD) of nutrients and amino acids was evaluated. In Poodles, the digestibility of dry matter, crude protein, nitrogen-free extract, and metabolizable energy was higher in adults and seniors than in puppies ($p < 0.05$), with most amino acids also showing significant age-related differences ($p < 0.001$). In Maltese dogs, crude protein and metabolizable energy digestibility were higher in adults, whereas nitrogen-free extract digestibility was lower in seniors ($p < 0.01$), and age-related differences in amino acids were limited. These findings indicate that nutrient and amino acid utilization varies across life stages and differs between breeds. This study provides fundamental data for precision nutrition and dietary formulation in companion dogs.

Key words : apparent total tract digestibility (ATTD), amino acids, age group, dog breeds

Evaluation of the nutritional composition of food additive by-products as potential alternative feed resources for broilers

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This study was conducted to analyze the nutritional composition of by-products generated during the manufacturing process of food additives (e.g., amino acids), and to evaluate their feasibility as alternative feed resources for broilers.

The primary objective of this research is to present a circular livestock production model and reduce feed costs by recycling food industry by-products into high-value-added feed resources. Compositional analysis revealed that the crude protein content of the by-products ranged from 45.0% to 62.5%, which is comparable or superior to that of soybean meal. The Metabolizable Energy (ME) was measured between 2,800 and 3,200 kcal/kg, possessing an energy value similar to corn, the primary ingredient in broiler diets. Notably, the amino acid profile showed that levels of Glutamic Acid, Lysine, and Methionine were 2 to 3 times higher than those found in typical cereal by-products. The analysis confirms that these food additive by-products possess exceptional nutritional value as ‘high-protein concentrated feed resources.’ The results suggest that they can effectively replace synthetic amino acids and conventional protein sources in broiler diets. Future feeding trials are expected to establish optimal inclusion rates, enabling the development of an economically efficient feeding system.

Key words : food additive by-products, broiler feed, crude protein

Energy availability and nitrogen utilization of cheese by-products in growing pigs

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Cheese by-products, including trimming losses, processing residues, and off-specification products, are generated during dairy production and may serve as a potential feed ingredient for swine diets. However, their nutritional value can vary considerably depending on the type of cheese, salt content, and the extent of whey removal, necessitating a quantitative evaluation of energy and nitrogen utilization prior to their practical application. Therefore, this study was designed to evaluate the energy and nitrogen utilization of three cheese by-products (mozzarella, gouda, and cheddar) in growing pigs, with corn used as a reference ingredient. A metabolism trial was conducted to determine the apparent total tract digestibility (ATTD) of gross energy (GE), including digestible energy (DE), metabolizable energy (ME), and nitrogen balance parameters. Feces and urine were quantitatively collected, and GE and nitrogen contents were analyzed to calculate energy and nitrogen utilization. The results showed that three types of cheese by-products had higher DE and ME values than those of corn, suggesting their potential as alternative energy sources in swine diets. In conclusion, cheese by-products may be viable alternative energy sources in swine diets, and their nutritional value should be further validated to support practical feed formulation.

Key words : cheese by-products, energy utilization, metabolizable energy, nitrogen balance, pigs

Capsaicin, Piperine, Sinigrin이 *Salmonella thompson*의 SPI-1 유전자 발현 및 마우스 장 상피세포 침투에 미치는 억제 효과

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살모넬라균에 의한 식중독은 계란 및 가금육을 매개로 지속적으로 발생하고 있어 식품 안전 분야에서 위협이 되고 있다. 특히 항생제 내성 균주의 증가로 인해 병원성 인자를 직접 표적하는 항독성 전략이 새로운 접근법으로 부각되고 있다. 본 연구에서는 Capsaicin, Piperine, Sinigrin이 *Salmonella Thompson*(*S. Thompson*)의 제3형 분비 시스템(T3SS-1) 조절 유전자 및 숙주 세포 침투에 미치는 영향을 평가하여 *S. Thompson*에 의한 수직전파 억제제로서의 가능성을 확인하고자 하였다. 3가지 화합물의 최소 억제 농도(MIC)는 Capsaicin과 Sinigrin이 1.5 mM, Sinigrin은 1.0 mM으로 확인되었으며, MIC 이하 농도(500 μ M)에서 *S. Thompson*의 증식, 운동성 및 마우스 장 상피세포에 영향을 미치지 않았다. 세포 부착과 달리 세포 침투는 농도 의존적으로 유의하게 억제되었으며, 대조군 대비 500 μ M에서 Capsaicin은 60.7%, Piperine은 68.6%, Sinigrin은 65.2%의 침투 억제 효과를 나타내었다. Q-PCR 분석 결과, 3가지 화합물 모두 hilD-hilC-rtxA-hilA 조절 네트워크 내 주요 유전자의 전사 수준을 유의적으로 억제하였으며, Capsaicin과 Sinigrin은 hilD의 발현을 각각 87.5%, 88.9%, Piperine은 hilC의 발현을 약 92.4% 억제하여 T3SS-1의 활성을 효과적으로 감소시켰다. 또한 효과 단백질 유전자인 sipA, sipB, sipC의 발현도 유의적인 감소가 확인되었다. 이는 3가지 화합물이 살모넬라의 증식에 직접적인 관여없이 T3SS-1의 활성을 저해하여 *S. Thompson*의 수직전파 제어에 활용될 수 있는 천연 항독성 억제제의 가능성을 시사한다. 본 연구 결과는 향후 식품 및 사료용 차세대 항생물질로서의 실용화를 위한 기초 자료가 될 수 있다.

Key words : *Salmonella thompson*, anti-virulence strategy, SPI-1, cell invasion, phytochemical

Plasma metabolic responses to reduced dietary crude protein and graded lysine supplementation in finishing pigs

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This study was conducted to evaluate the effects of reducing dietary crude protein (CP) by 1 percentage point and supplementing lysine (Lys) at graded levels on growth performance, carcass traits, meat quality, nitrogen utilization, blood parameters, and plasma metabolites in finishing pigs. The dietary treatments consisted of a control diet containing 14% CP and 0.91% Lys, and three reduced-CP diets containing 13% CP with 0.91%, 0.98%, or 1.06% Lys. Two experiments were conducted using the same dietary treatments. In the feeding trial, 48 finishing pigs with an initial body weight of 85 ± 5 kg were allotted to four dietary treatments for 35 days, with three pigs per pen. In the metabolism trial, 12 pigs were assigned to the four treatments for 7 days in metabolism cages, with three pigs per treatment. In the feeding trial, reducing dietary CP improved feed efficiency, expressed as the gain-to-feed ratio (G:F; $p < 0.001$), with the greatest responses observed in pigs fed the 13% CP diets supplemented with 0.98% or 1.06% Lys. However, carcass yield decreased as dietary Lys concentration increased ($p = 0.011$). In the metabolism trial, body weight gain increased linearly with increasing dietary Lys concentration ($p = 0.044$). Meanwhile, reducing dietary CP by 1 percentage point significantly decreased retained nitrogen ($p = 0.038$) and absorbed nitrogen ($p = 0.005$). Regarding blood parameters, blood glucose increased linearly with increasing dietary Lys concentration ($p = 0.018$), whereas neutrophil counts showed a quadratic response to dietary Lys level ($p = 0.029$). In addition, increasing dietary Lys levels increased plasma metabolites associated with energy metabolism and the TCA cycle, including glucose-6-phosphate, pyruvate, citrate, and succinate ($p < 0.05$). Overall, these results suggest that reducing dietary CP by 1 percentage point, when accompanied by appropriate Lys supplementation, may maintain or improve growth performance and nitrogen utilization in finishing pigs without adversely affecting carcass weight or meat quality.

Key words : lysine, pig, protein

Effects of replacing animal protein with *Bacillus*-fermented soybean meal-based functional protein on gut microbiota of weaned pigs

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This study investigated the effects of replacing animal protein with *Bacillus*-fermented soybean meal-based functional protein (FSBM) on gut microbiota of weaned pigs. Ninety-six newly-weaned pigs (initial body weight [BW] = 7.75 ± 1.12 kg; 28 days of age) were randomly allotted to four dietary treatments (seven replicates/treatment; four pigs/pen) in a randomized complete block design. Initial BW considered as a blocking factor. Pigs were fed for 35 days in two-phase feeding programs (phase 1, day 1–14; phase 2, day 15–35). Dietary treatments included positive control (PC, basal diet with blood plasma 3% and fish meal 5% for phase 1 and phase 2, respectively); negative control (NC, basal diet based on corn and soybean meal); FSBM1 (basal diet with FSBM replacing 5% and 5% of animal protein for phase 1 and phase 2, respectively); FSBM2 (basal diet with FSBM replacing 5% and 3% of animal protein for phase 1 and phase 2, respectively). At the end of the study, fecal samples were collected from six pigs per treatment to evaluate gut microbial diversity and relative abundance. Bray-Curtis distance showed a difference ($r^2 = 0.19$; $p < 0.05$) among dietary treatments. Pigs fed FSBM2 had higher ($p < 0.05$) the relative abundance of *Clostridium* than those fed PC. In conclusion, dietary FSBM replacing animal protein modulated the gut microbial community of weaned pigs.

Key words : gut microbiota, functional protein, weaned pigs

Evaluation of *Bacillus*-fermented soybean meal based functional protein substitute for animal-derived protein on growth performance and intestinal morphology of weaned pigs

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The study was conducted to evaluate the effects of *Bacillus*-fermented soybean meal based functional protein (BFSBM) on growth performance and intestinal morphology of weaned pigs. Weaned pigs [n = 112; 7.43 ± 0.82 kg of initial body weight(BW)] were randomly assigned to four dietary treatments (4 pigs/pen; 7 replicates/treatment) in a randomized complete block design (block: initial BW) for 5 weeks. The 35-day feeding trial was divided into two phases (phase 1: day 1–14; phase 2: day 15–35). The dietary treatments were: 1) a basal corn-soybean meal diet (NC), 2) basal diet with 3% plasma protein and 5% fish meal during phase 1 and 2, respectively (PC), 3) basal diet with 3% dried porcine solubles (DPS), and 4) basal diet with 5% and 3% BFSBM during phase 1 and 2, respectively (BFSBM). All pigs and the amount of pen feed residual were weighed and recorded on days 1, 14 and 35 for growth performance. After euthanizing the pigs, a 3 cm segments from each of the duodenum, jejunum, and ileum were collected for intestinal morphology analysis. Pigs fed the NC diet had lower ($p < 0.05$) average daily gain compared with other treatments during overall period. The number of goblet cells in the ileum was significantly higher ($p < 0.05$) in the BFSBM group compared to the NC and DPS groups. These results indicated that the dietary BFSBM without impairing on growth performance and also enhance intestinal health of weaned pigs. In conclusion, BFSBM can be an effective substitute for protein sources in nursery diet.

Key words: feed, functional protein, growth performance, intestinal morphology, weaned pigs

Evaluation of *Bacillus*-fermented soybean meal as a functional protein substitute for animal-derived sources on diarrhea frequency, blood profiles, and immune responses

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This study was conducted to investigate the effects of *Bacillus*-fermented soybean meal based functional protein (BFSBM) on diarrhea incidence, blood profiles, and immune responses of weaned pigs. A total of 112 weaned pigs (initial body weight [BW]: 7.43 ± 0.82 kg) were allotted to four dietary treatments in a randomized complete block design (block: initial BW) for 5 weeks, with 4 pigs per pen and 7 replicates per treatment. The 35-day feeding trial was divided into two phases (phase 1: day 1–14; phase 2: day 15–35). The dietary treatments were: 1) a basal corn-soybean meal diet (NC), 2) basal diet including 3% plasma protein and 5% fish meal during phase 1 and 2, respectively (PC), 3) basal diet with 3% dried porcine solubles (DPS), and 4) basal diet with 5% and 3% BFSBM during phase 1 and 2, respectively (BFSBM). Daily fecal score from 1 to 5 (1 = hard feces and 5 = watery diarrhea) was visually evaluated and recorded by two independent examiners for the first two weeks after weaning. The frequency of diarrhea was calculated as the average number of pen days with a fecal score of 4 or higher. Blood samples were collected for analyzing blood profiles and immune responses. On day 14, the BFSBM group showed lower ($p < 0.05$) hematocrit compared with the NC and DPS groups. Both PC and BFSBM groups had higher ($p < 0.05$) IgG levels compared with the NC group. Furthermore, IgA levels were significantly higher ($p < 0.05$) in the PC group than in the NC and DPS groups. In conclusion, BFSBM shows potential as a viable alternative protein source that supports immune responses without adversely affecting the blood profiles of weaned piglets.

Key words: blood profiles, diarrhea, functional protein, immune responses, weaned pigs

Effects of fermented soybean meal-based functional protein on growth performance, nutrient digestibility, and intestinal morphology of weaned pigs

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The objective of this study was to evaluate the effects of a fermented soybean meal (FSBM)-based functional protein as an alternative protein source on growth performance, nutrient digestibility, and intestinal morphology of weaned pigs. A total of 112 weaned pigs (7.75 ± 1.12 kg of initial body weight; 28 days of age) were assigned to 4 treatments in a randomized complete block design for 35 days with a two-phase feeding program (phase 1, day 1–14; phase 2, day 15–35). Dietary treatments included positive control (PC, basal diet containing 3% plasma protein during phase 1 and 5% fish meal during phase 2); negative control (NC, corn and soybean meal based diet); FSBM1 (basal diet containing 5% FSBM); FSBM2 (basal diet containing 5% and 3% FSBM during phase 1 and phase 2). The NC group showed lower ($p < 0.05$) average daily gain from day 1 to 35 than the other treatments. Dietary FSBM1 and 2 groups improved ($p < 0.05$) apparent ileal digestibility of energy, crude protein, and dry matter compared with the NC group. Dietary FSBM 1 and 2 also improved ($p < 0.05$) apparent total tract digestibility of crude protein compared with the NC diet. In the ileum, pigs fed FSBM2 had higher ($p < 0.01$) goblet cell numbers than those fed PC and NC diets. In conclusion, dietary FSBM can be used as an effective alternative protein source to improve growth performance and intestinal health in weaned pigs.

Key words : functional protein, gut health, weaned pigs

Effects of fermented soybean meal-based functional protein on immune responses and diarrhea incidence of weaned pigs

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The present study investigated the potential of a fermented soybean meal (FSBM)-based functional protein as an alternative protein source by evaluating frequency of diarrhea, blood profiles, and immune responses of weaned pigs. A total of 112 weaned pigs (7.43 ± 1.12 kg of initial body weight; 28 days of age) were assigned to 4 treatments in a randomized complete block design for 35 days with a two-phase feeding program (phase 1, day 1–14; phase 2, day 15–35). Dietary treatments included positive control (PC, basal diet containing plasma protein during phase 1 and fish meal during phase 2); negative control (NC, corn and soybean meal based diet); FSBM1 (basal diet containing 5% FSBM); FSBM2 (basal diet containing 5% and 3% FSBM during phase 1 and phase 2). Dietary FSBM1 and 2 improved ($p < 0.05$) total antioxidant capacity and reduced ($p < 0.05$) TNF- α and IL-8 concentrations on day 14 compared with the NC diet. Pigs fed FSBM 1 and 2 diets had higher ($p < 0.05$) IgG concentration on day 14 and 35 than those fed NC diet. In addition, FSBM 1 and 2 groups had increased ($p < 0.05$) IgA concentration on day 35 compared with the NC group. In conclusion, dietary FSBM can be used as an effective alternative protein source to improve immune responses and systemic health in weaned pigs.

Key words : alternative protein, immune response, weaned pigs

Effects of dietary bacteriophage supplementation on growth performance, jejunal morphology, and cecal bacterial population in broiler chickens raised under multiple stress conditions

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This study aimed to investigate the effect of dietary bacteriophage (BP) supplementation as an alternative to antibiotics on growth performance, jejunal morphology, and cecal bacterial population in broiler chickens under multiple stress (MS) conditions. A total of 2,280 one-d-old Ross 308 broiler chickens were randomly allotted to 8 treatments with 5 replicates per treatment in factorial arrangements of 2 environment conditions and 4 dietary treatments. Birds were raised under either heat stress (HS) conditions ($31 \pm 1.0^{\circ}\text{C}$ for 8 h/d and $28 \pm 2.0^{\circ}\text{C}$ for 16 h/d) and normal stocking density (SD; 9 birds/m²) or MS conditions of both HS and high SD (18 birds/m²). Dietary treatments included a basal diet (CON) or the basal diet supplemented with 0.05% ampicillin (AB), 0.05% BP (BP5), or 0.10% BP (BP10). Experiment lasted for 35 d. Results indicated that an interaction ($p < 0.05$) was observed for feed conversion ratio (FCR) because no effect of dietary treatments was detected under HS and normal SD, whereas under MS conditions, the AB diet decreased FCR compared with the CON and BP5 diets ($p < 0.05$) with the BP10 diet showing the similar FCR to the AB diet. Despite no interaction for jejunal morphology, villus height:crypt depth ratio was decreased by MS conditions with no main effects of dietary treatments. For cecal bacterial population, *Lactobacilli:Enterobacteriaceae* ratio (L:E ratio) tended to be greater ($p = 0.057$) in the AB and BP diets than in the CON diet although interaction and the main effects of environment conditions on L:E ratio were insignificant. In conclusion, although no clear interactive effects are identified, MS conditions impair broiler performance and jejunal morphology, whereas dietary BP supplementation regardless of environmental stress shows a beneficial effect on intestinal bacterial populations as similar to AB supplementation despite little benefits on growth performance and intestinal morphology in broiler chickens.

Key words : broiler chickens, bacteriophage, antibiotics, jejunal morphology, multiple stress condition

Meta-analysis of the effect of reducing crude protein levels in diets on growth performance in broiler chickens during growing and finishing phases

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The current meta-analysis was conducted to investigate the effect of reducing crude protein (CP) levels in diets on growth performance in broiler chickens during growing and finishing phases. A total of 44 studies published between 2007 and 2026 were selected for each growing (11–24 d of age) and finishing (25–42 d of age) phase to evaluate the responses of broiler performance, including average daily gain (ADG), average daily feed intake (ADFI), and feed conversion ratio (FCR), to feeding diets with varying CP levels. Regression analysis was conducted to generate the linear, quadratic, broken-line linear plateau (BLL), and broken-line quadratic plateau (BLQ) models to identify performance responses with decreasing CP levels. For ADG, linear and BLQ models were significant ($p < 0.05$) in the growing phase, whereas the linear and BLL models were significant ($p < 0.05$) in the finishing phase. For FCR, only linear and BLL models were significant in both growing and finishing phases. No significant models were verified for ADFI in both phases. Finally, the BLL models for FCR were used to estimate the breaking points, which were considered minimal CP levels in diets to maintain FCR. Accordingly, the minimal CP levels in broiler diets were estimated to be 22.2% CP for the growing phase and 18.8% CP for the finishing phase. Furthermore, it was also predicted that every 1% reduction in dietary CP below these minimal CP levels increased FCR by 0.02 and 0.04 units for growing and finishing phases, respectively. In conclusion, the estimated minimal CP levels in low-CP diets and their predicted performance change from this meta-analysis may offer a practical and applicable strategy to produce low-CP diets without sacrificing growth performance in broiler chickens.

Key words : broiler chicken, crude protein, growth performance, meta-analysis, regression model

Monitoring and detection characteristics of 327 pesticide residues in animal feed distributed in South Korea

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Continuous surveillance of pesticide residues in animal feed is imperative for ensuring the safety of livestock products and bolstering consumer confidence. This study investigated the prevalence and detection characteristics of pesticide residues in 301 samples of animal feed collected from the South Korean market between 2023 and 2025. Multiresidue analysis targeting 327 pesticide components was performed using GC-MS/MS and LC-MS/MS, in accordance with the official ‘Standard Analysis Methods for Feeds’ (MAFRA) and the ‘Multiresidue Method’ (NAQS). The results demonstrated that pesticide residue levels in all examined samples complied with the maximum residue limits (MRLs) established by the official ‘Criteria and Standards for Feeds’ (MAFRA), indicating a robust safety profile. However, nine pesticide components were consistently detected throughout the three-year study period, albeit at concentrations below the MRLs. Notably, the detection frequency of piperonyl butoxide (PBO), a pesticide synergist, exhibited a significant annual upward trend. Furthermore, distinct patterns of co-occurrence were observed between PBO, insecticides (pirimiphos-methyl and deltamethrin), and a herbicide (glyphosate). In conclusion, although pesticide residues in animal feed consistently demonstrated compliance with safety standards throughout the study period, the rising prevalence of synergists signifies a transition in pest management strategies necessitated by evolving agricultural conditions, such as climate change. The identified patterns of co-detected components provide a comprehensive basis for establishing novel strategic directions in future feed safety management. These findings emphasize the imperative to implement rigorous surveillance systems adaptable to emerging pesticide usage trends and to develop proactive risk management frameworks substantiated by longitudinal data.

Key words: animal feed, pesticide residues, detection characteristics, pesticide synergist, piperonyl butoxide

Monitoring and occurrence of pesticide residues in complete pet food distributed in the Korean market: a three-year study (2023-2025)

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Given the sustained growth in pet-owning households, ensuring the safety and enhancing the risk management frameworks for pet food have become increasingly important. This study was conducted to evaluate the occurrence and residue levels of pesticides in pet food and to establish a baseline for the development and refinement of regulatory standards. Between 2023 and 2025, a total of 463 samples of complete pet food were collected from the Korean market for longitudinal monitoring. In accordance with the 'Official Standard Analysis Methods for Feeds' (MAFRA) and the 'Multiresidue Method' (NAQS), 327 pesticides were analyzed using GC-MS/MS and LC-MS/MS. The analytical results indicated that all 463 samples complied with the Maximum Residue Limits (MRLs) defined by the 'Criteria and Standards for Feeds' (MAFRA), with concentrations remaining within regulatory limits. Although 22 pesticide residues were consistently detected throughout the three-year study period, their concentrations were present at trace levels below the MRLs, and no instances of non-compliance were identified among the tested samples. These findings demonstrate that complete pet foods distributed in the Korean market are appropriately managed within established regulatory safety systems. In conclusion, the levels of pesticide residues in pet food distributed in Korea appear to be within safe levels relative to current regulatory standards. However, given the consistent annual detection of specific pesticide residues, continued monitoring and the implementation of a proactive risk management system incorporating evolving ingredient supply chains and residue patterns are recommended to further enhance pet food safety.

Key words : complete pet food, pesticide residues, monitoring

Development of an LC-MS/MS-based simultaneous analytical method for vitamins A and D in pet feeds

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This study aimed to develop an analytical method for evaluating nutritional compliance in pet feeds following the establishment of new labeling regulations for dog and cat feeds. However, the current HPLC-based vitamin analysis method has limitations in analyzing trace vitamins in compound pet feeds. Therefore, a pretreatment procedure and an LC-MS/MS-based analytical method were developed for the simultaneous quantification of vitamins A and D. The proposed method simplified the conventional multi-step extraction process involving saponification and hexane extraction, thereby improving pretreatment efficiency. A high-sensitivity mass spectrometry system enabled the simultaneous analysis of vitamins A and D. Additionally, post stable isotope dilution (SID) was applied to correct matrix-induced interferences, ensuring reliable quantification. Method validation demonstrated excellent linearity, with correlation coefficients (R^2) of 0.99 or higher for both vitamins A and D, satisfying the validation criterion of $R^2 \geq 0.98$. The limits of detection (LOD) and quantification (LOQ) were 17–18 ng/mL and 51–53 ng/mL, respectively. Furthermore, accuracy evaluation using certified reference materials (NIST SRM 1869 and 1849b) and AAFCO reference standards yielded recovery rates ranging from 73.1% to 108.8%, meeting the acceptance criteria of the official feed analysis methods. Compared with conventional HPLC methods, this approach improved sensitivity and selectivity while reducing pretreatment time, demonstrating its applicability for evaluation of nutritional compliance and quality control of pet feeds.

Key words : LC-MS/MS, vitamin A, vitamin D, pet feed, stable isotope dilution, method validation

Effects of combined synbiotic and benzoic acid supplementation on short-chain fatty acid profiles and fecal microbiota in swine

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This study investigated the effects of 0.1% combined synbiotic and benzoic acid supplementation on short-chain fatty acid (SCFA) profiles and fecal microbiota in swine. A total of 23 pigs were assigned to two dietary groups: control (CON, n = 12) and synbiotic plus benzoic acid supplementation (SYN, n = 11). After a 7-week feeding period, fecal samples were collected for SCFA profiling using liquid chromatography-tandem mass spectrometry (LC-MS/MS), and fecal microbiota were analyzed by 16S rRNA gene sequencing. The mean concentrations of all analyzed SCFAs were lower in the SYN group than in the CON group, with significant reductions in acetic, butyric, lactic, and valeric acids ($p < 0.05$). Microbiota analysis showed that the SYN group had a significantly lower Chao1 richness index than the CON group ($p < 0.05$), while microbial composition differed between groups. LEfSe and correlation analyses indicated that specific bacterial taxa were associated with altered SCFA profiles. These findings suggest that combined synbiotic and benzoic acid supplementation is associated with reduced fecal SCFA concentrations and altered microbial richness and composition in swine.

Key words : feces, microbiota, short-chain fatty acids, swine, synbiotics, benzoic acid

Monitoring and characterization of multi-component pesticide residue patterns in single-ingredient feed

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The monitoring of pesticide residues in plant-based single-ingredient feed, the foundational raw material for animal feed, is essential for ensuring safe livestock production and effective feed risk management. This study monitored pesticide residues in plant-based single-ingredient feed randomly collected from the Korean market from 2023 to 2025 to characterize the occurrence and residue patterns of pesticide contaminants. A total of 411 samples were analyzed for 327 pesticide components using GC-MS/MS and LC-MS/MS, in accordance with the official ‘Standard Analysis Methods for Feeds’ (MAFRA) and the ‘Multiresidue Method’ (NAQS). The analysis demonstrated that 14 pesticide components were consistently detected over the three-year study period. Notably, the study identified frequent instances of pesticide co-occurrence, where multiple residues were present in specific feed samples. In particular, co-detection of two pesticides was observed in 34 cases (8.3%), and multiple residue occurrences involving three or more pesticides were found in 7 cases (1.7%). The analysis of these co-detected pesticides by functional category and purpose revealed the concurrent detection of insecticides and synergists (e.g., Piperonyl butoxide) and the combined detection of multiple fungicides (e.g., Azoxystrobin + Propiconazole), reflecting multi-target pest and disease management during crop cultivation and storage. In conclusion, the multi-component residue patterns of pesticides observed in this study suggest a potential association with the pest control history during the cultivation and storage stages of plant-based single-ingredient feed. These findings highlight the importance of continuous monitoring and data accumulation regarding the identified co-occurrence patterns, alongside existing single-substance assessments. This study provides baseline data that can contribute to the development of more precise safety management strategies for feed ingredients in the future.

Key words : plant-based single-ingredient feed, pesticide residues, monitoring, synergist, multi-residue patterns

Effects of crude protein reduction and a moderate increase in metabolizable energy on growth performance, digestibility, and blood metabolites in pigs

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Reducing dietary crude protein (CP) with essential amino acid (AA) supplementation can improve nitrogen utilization; however, it may compromise growth performance if nitrogen supply becomes limiting. This study evaluated the effects of dietary CP reduction on growth performance and metabolic responses in growing–finishing pigs. Two 28-day feeding trials were conducted using pigs with initial body weights of 55 and 70 kg. In Experiment 1, pigs were fed diets containing 15.5% or 13.5% CP, and in Experiment 2, CP levels were 13.5% or 11.5%. Reducing dietary CP decreased average daily gain in growing pigs whereas feed intake and gain-to-feed ratio were not affected. Low-CP diets reduced apparent total tract CP digestibility and blood urea nitrogen, and altered circulating proline and serine concentrations, while most essential AA were maintained. In finishing pigs, low-CP feeding downregulated jejunal AA transporter and mammalian target of rapamycin gene expression. However, fecal fermentation characteristics, microbial composition, and carcass traits were not significantly affected by dietary treatments. Overall, dietary CP reduction influenced growth performance and metabolic responses in growing–finishing pigs, suggesting that adequate nitrogen supply remains important even when essential AA requirements are met.

Key words : pigs; crude protein; metabolizable energy; amino acids

Effects of feed processing and different energy and protein level in lactating sows under hot ambient

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This study evaluated the effects of feed processing and dietary energy-protein strategies on physiological responses, productive performance, stress biomarkers, and fecal microbiota of lactating sows exposed to heat stress. Fifty multiparous Landrace × Yorkshire sows were assigned to five dietary treatments differing in feed form, metabolizable energy, crude protein, and amino acid supplementation. Feed processing did not significantly affect rectal temperature, sow feed intake, body weight change, reproductive performance, stress biomarkers, or fecal microbial populations. Respiratory rate was mostly unaffected by dietary treatment, although it increased during late lactation in sows fed the high-ME, low-CP pelleted diet with AA supplementation. Sow body weight at weaning was higher in sows fed higher-CP diets, and piglet weaning weight and average daily gain were improved by higher dietary ME and CP. Inflammatory cytokines, antioxidant capacity, hair cortisol, and fecal microbiota were not affected by the treatments, but malondialdehyde concentration increased with higher dietary ME. Overall, pelleted diets containing higher ME and adequate CP improved sow body weight at weaning and supported better piglet growth performance under heat stress.

Key words : cortisol, homeostasis, lactation, lipid peroxidation, microbiota

Host-derived *Limosilactobacillus reuteri* supplementation improves piglet growth and gut integrity in heat-stressed sows

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Heat stress (HS) severely compromises sow productivity during lactation by disrupting feed intake, endocrine regulation, and gut integrity, ultimately impairing offspring growth. This study evaluated the effects of dietary probiotic supplementation (*Lactobacillus reuteri*) on performance, systemic responses, and fecal microbiota modulation in lactating sows under HS conditions. Forty multiparous sows (Landrace × Yorkshire) were assigned to four treatments: thermoneutral (TN), heat stress without supplementation (CN), HS + *L. reuteri* MP1 (L1), and HS + *L. reuteri* MP3 (L2). Results showed that HS elevated hair cortisol concentrations, whereas L2 supplementation significantly improved average daily feed intake and restored serum prolactin levels compared to the CN group. Although HS increased inflammatory markers (TNF- α , IL-1 β) and oxidative stress, L2 treatment effectively lowered TNF- α and enhanced antioxidant capacity. Interestingly, gut barrier markers showed distinct responses, with L2 affecting serum zonulin levels and CN increasing occludin concentrations. Microbiota analysis revealed that L2 supplementation increased the relative abundance of beneficial taxa, such as Christensenellaceae and its R-7 group, at the family and genus levels. These findings demonstrate that *L. reuteri* supplementation, particularly the MP3 strain, alleviates HS-induced physiological disturbances by improving immune balance, endocrine regulation, and gut microbiota composition. Consequently, probiotic supplementation represents an effective nutritional strategy to enhance lactational resilience and offspring growth performance under heat stress conditions.

Key words : heat stress, lactating sows, *Lactobacillus reuteri*, probiotics, litter performance, gut microbiota, oxidative stress

Strategic nutritional restriction followed by refeeding induces compensatory growth, improves jejunal morphology, and modulates the gut microbiome in weaning pigs

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This study investigated whether short-term dietary protein and energy restriction followed by balanced refeeding could induce compensatory growth and modulates physiological, intestinal morphological and gut microbial responses in weaning pigs. A total of 80 YLD weaning pigs were randomly assigned to two treatments, with 10 replicates per treatments. The dietary program consisted of two phases: TRT1 pigs received a balanced diet during both Phase 1 and 2 (week 0–3,3–6), whereas TRT2 pigs received a low-protein and low-energy (LP-LE) diet during Phase 1 followed by a balanced diet during Phase 2. During the restriction phase, TRT2 pigs exhibited lower body weight, average daily gain (ADG), and gain-to-feed ratio (G:F) than TRT1, despite a higher average daily feed intake (ADFI). Plasma ghrelin level was higher in TRT2 pigs, indicating an adaptive hormonal response to nutritional restriction. During recovery, TRT2 pigs exhibited compensatory growth and no significant differences in final body weight, ADG, ADFI, or G:F between treatments by week 6. At week 6 TRT2 pigs showed greater villus height, lower crypt depth, and a higher villus-to-crypt ratio than TRT1 indicating improved jejunal morphology. Gut microbiome analysis showed no significant differences at week 3, whereas TRT2 pigs had lower richness and evenness at week 6. Beta-diversity revealed distinct clustering between treatments at both Week 3 and 6, indicating treatment-related shifts in bacterial community composition. In conclusion, the strategic nutritional restriction followed by balanced refeeding may be a useful nutritional approach for modulating intestinal development and physiological adaptation in weaning pigs.

Key words : compensatory growth, nutritional restriction, gut microbiome, intestinal morphology, weaning pigs

Dietary supplementation with *Limosilactobacillus reuteri* enhances lactational performance and mitigates heat stress induced physiological disturbances in sows

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This study was conducted to evaluate the effects of dietary supplementation with *Limosilactobacillus reuteri* (*L. reuteri*) on sow performance, litter growth, inflammatory and oxidative stress status, intestinal barrier function, endocrine responses, and fecal microbial composition under heat stress conditions. A total of 40 multiparous sows (Landrace × Yorkshire) were assigned to three treatments: thermoneutral condition (TN), heat stress without supplementation (CN), and heat stress with 0.05% *L. reuteri* supplementation (LR5). Heat stress increased hair cortisol concentrations and reduced average daily feed intake (ADFI), litter weight at weaning, and piglet body weight. In addition, serum concentrations of TNF- α , IL-10, and IL-1 β were elevated in heat-stressed sows compared to those under thermoneutral conditions. Although no significant differences were observed, the LR5 treatment numerically improved ADFI and reduced TNF- α concentrations, indicating a partial mitigation of the negative effects induced by heat stress. Overall, *L. reuteri* supplementation showed protective effects against heat stress-induced metabolic, inflammatory, and microbial changes in lactating sows. Probiotic supplementation may improve feed intake, regulate immune responses, and enhance lactation performance and litter growth under heat stress conditions.

Key words : probiotics, climate change, stress, antioxidant, lactating sows

Classification and market analysis of commercial prescription diets in Korea according to PARNUTs particular nutritional purposes

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Commercial prescription diets distributed in Korea are marketed for various disease management purposes; however, systematic guidelines and classification frameworks for these products remain insufficient, and they are currently regulated as “other pet foods” in Korea. In this study, a purpose-oriented classification system based on the EU’s PARNUTs (Particular Nutritional Purposes) was applied to 213 commercial prescription diet products distributed in Korea, and their market characteristics according to species, formulation type, and nutritional purposes were analyzed. Dog products accounted for 64.06% and cat products for 35.94% of the market. Dry formulations represented 64.13%, whereas wet formulations accounted for 35.87%, indicating a market structure predominantly centered on dog and dry-formulated diets. Among all products evaluated, 61 were classified as single-function diets and 152 as multifunctional diets, demonstrating a high prevalence of multifunctional formulations. The most frequently identified nutritional purposes were “Support of renal function in case of chronic renal insufficiency” (33), “Reduction of ingredient and nutrient intolerances” (29), and “Compensation for maldigestion” (21). In contrast, categories such as “Reduction of iodine levels in feed in case of hyperthyroidism” (1) showed extremely low representation, while no products corresponding to “Reduction of acute intestinal absorptive disorders” were identified. These findings may provide foundational data for the future establishment of regulatory standards and management systems for companion animal prescription diets in Korea.

Key words : companion animal, prescription diet, pet food, PARNUTs

Cytotoxic effects of deoxynivalenol and fumonisin B1 in porcine ileum-derived organoids

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Deoxynivalenol (DON) and Fumonisin B1 (FB1) are major *Fusarium*-derived mycotoxins frequently co-contaminate swine feed, raising concerns about combined toxicological effects on intestinal health. This study investigated the single and binary cytotoxic effects of DON and FB1 on porcine ileum-derived organoid and single-cell cultures using the CCK-8 assay. DON alone exhibited potent dose-dependent cytotoxicity, reducing organoid viability to approximately 30% at 2 μ M, while FB1 alone showed negligible cytotoxicity up to 200 μ M. Binary co-treatment significantly reduced viability to 47–57% in organoids and 16–33% in single-cell cultures compared to the control. Short-term exposure (0–10 hours) produced no significant acute cytotoxic effects, indicating a time-dependent toxicity profile. These findings demonstrate that DON is the primary driver of cytotoxicity in porcine intestinal cells, while FB1 alone is non-cytotoxic but may potentiate DON-induced intestinal damage under binary co-exposure conditions. The results underscore the importance of considering mycotoxin co-contamination in feed safety risk assessments for swine.

Key words : cell viability, deoxynivalenol, fumonisin B1, mycotoxin co-contamination, porcine intestinal organoids

Fatty acid composition and anti-inflammatory activity of black soldier fly (*Hermetia illucens*) larval oil

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Black soldier fly (*Hermetia illucens*) larvae (BSFL) are nutrient-dense, containing 25.8%–33.0% fat. Despite its rich fatty acid profile, BSFL oil is often discarded as a byproduct. However, anecdotal evidence in aquaculture and poultry sectors suggests that BSFL oil promotes growth and enhances disease resilience. This study evaluates the anti-inflammatory potential of BSFL oil (HIO) to establish its value as a functional feed additive. HIO was extracted via screw press at 120°C after hot-air drying larvae at 60°C. Cytotoxicity on RAW 264.7 macrophages was assessed using MTS assays (1.58%–12.5% v/v). Anti-inflammatory activity was evaluated by measuring nitric oxide (NO) production and pro-inflammatory cytokine levels (TNF- α , IL-1 β , and IL-6) in lipopolysaccharide (LPS)-stimulated cells. HIO showed no cytotoxicity up to 6.25 % (LC₅₀: 10.3 $\pm$ 0.45%). While LPS stimulation significantly induced NO and cytokine expression, HIO treatment effectively suppressed these markers in a dose-dependent manner. HIO effectively attenuates key inflammatory markers without significant cytotoxicity. These findings suggest that HIO is a promising nutraceutical feed additive that can enhance animal health and inflammatory resilience, providing a scientific basis for the high-value utilization of insect-derived oils.

Key words : *Hermetia illucens*, black soldier fly larvae oil, fatty acid, anti-inflammation, nutraceutical, feed additive

Effects of *Lactobacillus amylovorus* supplementation dosage on lactation performance and physiological responses in heat stressed sows

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This study evaluated *Lactobacillus amylovorus* (LA) supplementation on lactating sow performance and physiological responses under heat stress (HS). Forty multiparous sows (240.34 ± 11.57 kg) were assigned to a 2×3 factorial design: thermoneutral (TN), HS without supplementation (HSNS), HS + 0.01% LA (HL1), and HS + 0.05% LA (HL5). Chronic stress was assessed via hair cortisol alongside performance, immunity, antioxidant capacity, and fecal microbiota. Compared with TN, HSNS increased hair cortisol and reduced average daily feed intake (ADFI), litter weight, and piglet ADG ($p < 0.05$). In contrast, LA supplementation (HL1 and HL5) restored ADFI ($P < 0.05$). TNF- α and IL-1 β were lower in TN than other groups ($p < 0.05$), while IL-10 was higher in HSNS and HL1 vs. TN and HL5 ($p < 0.05$). Superoxide dismutase activity was lower in HSNS compared with HL1 and HL5 ($p < 0.05$). No treatment effects were observed for body weight, backfat, zonulin, or occludin. Fecal *Lactobacillus* spp. abundance was greater in HSNS and HL1 than TN ($p < 0.05$). In conclusion, dietary *Lactobacillus amylovorus* supplementation (0.05%) mitigates heat stress impairments by improving productive performance and physiological resilience in lactating sows.

Key words: feed intake, immune response, gut integrity, oxidative status, probiotics, performance, sows

Correlation analysis of bioactive compounds with antioxidant and anti-inflammatory properties in black soldier fly (*Hermetia illucens*) larval oil

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Black Soldier Fly (*Hermetia illucens*) oil (HIO) is rich in bioactives, yet the relationship between its antioxidant and anti-inflammatory properties remains poorly defined. This study investigated the correlations between bioactive compounds, factors related with antioxidant and anti-inflammatory activities of HIO. Antioxidant capacity was quantified through total phenolic content (TPC), total flavonoid content (TFC), and ABTS/DPPH radical scavenging assays. Anti-inflammatory activity was evaluated in LPS-stimulated RAW 264.7 cell by measuring nitric oxide (NO) production and pro-inflammatory cytokines (IL-1 β , IL-6, and TNF- α). Pearson correlation analysis was carried out by using SPSS S/W ver. 29.0. Correlation analysis revealed that antioxidant factors (TFC, TPC, ABTS, and DPPH) exhibited significant negative correlations with both NO production and pro-inflammatory cytokine expression. In contrast, strong positive correlations were observed among cytotoxicity, NO production, and cytokine levels, suggesting that HIO could potentially modulate the synergistic inflammatory cascade. The observed correlations suggest that antioxidant properties of HIO may contribute to its anti-inflammatory performance. These findings imply that HIO could serve as a promising nutraceutical feed additive to potentially improve animal health and physiological resilience.

Key words : *Hermetia illucens*, black soldier fly larvae oil, correlation, antioxidant, anti-inflammation, nutraceutical

Meta-analysis of the effect of reducing crude protein levels in diets on nitrogen excretion rate in broiler chickens during growing and finishing phases

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The current meta-analysis was conducted to investigate the effect of reducing crude protein (CP) levels in diets on the nitrogen (N) excretion rate (NER) in broiler chickens during growing and finishing phase. A total of 16 broiler studies with varying treatment levels of dietary CP, which were published between 2007 and 2026, were selected for the growing and finishing (11–42 d of age) phases. Regression analysis was conducted to generate the linear, quadratic, broken-line linear plateau (BLL), and broken-line quadratic plateau (BLQ) models to identify the responses of NER (%) with decreasing CP levels (%) in diets. Among these regression models, the linear model was only verified ($p < 0.05$) with a significant linear coefficient (estimate = 0.88; SE = 0.396; $p < 0.05$) and intercept (estimate = 13.35; SE = 1.691; $p < 0.05$). Based on model evaluation criteria, the linear model also showed the least AIC and BIC values among the evaluated models, indicating its best relative fit for NER. These results clearly indicate that decreasing CP levels in diets linearly decrease NER in broiler chickens. In addition, this linear model of [$Y = 0.88X + 13.35$, where X represents dietary CP level (%) and Y represents NER (%)] demonstrates that every 1 percentage point reduction in dietary CP levels decreases NER by 0.88 percentage point in broiler chickens during growing and finishing phases. In conclusion, our meta-analysis suggests a linear prediction model for NER and approximate reducing extents of NER with decreasing CP levels in broiler diets, which may aid in formulating low-CP diets to decrease N excretion from broiler production.

Key words : broiler chicken, crude protein, meta-analysis, nitrogen excretion rate, regression model

Effects of black soldier fly (*Hermetia illucens*) larvae oil on blood glucose, serum lipids, and liver enzyme: a meta-analysis

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Black soldier fly (*Hermetia illucens*) larvae oil (HIO) is rich in fatty acids, particularly lauric acid, which is recognized as a representative functional fatty acid. Recently, HIO as a health-functional material has increased due to its rich content of lauric acid and various bioactive compounds. Previous studies have reported that HIO exhibits beneficial effects on blood glucose regulation, serum lipid metabolism, antioxidant activity, anti-inflammatory activity, immune modulation, and liver function protection. In this study, a meta-analysis was conducted using studies published between 2017 and 2026 that investigated the effects of HIO on blood glucose, serum lipids, and liver enzyme. A total of 19 studies were included in the meta-analysis, with an overall effect size of 0.760, indicating a moderate-to-large effect. The effect sizes for blood glucose (ES = 0.817), serum lipids (ES = 1.038), and liver function (ES = 1.235) were all found to be large. The results of the meta-analysis demonstrated that HIO had significant beneficial effects on blood glucose, serum lipids, and liver enzyme. In particular, large effect sizes were observed for serum lipid and liver function improvement, suggesting that HIO has strong potential as a functional food ingredient and bioactive material. Furthermore, HIO may have considerable industrial value in the functional food and biotechnology industries because it is an eco-friendly and sustainable resource.

Key words : *Hermetia illucens*, black soldier fly larvae oil, blood glucose, serum lipid, liver enzyme, meta-analysis

Research trend analysis of swine nutrition and feed studies in Korea from 2023 to 2025

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This study systematically classified recent research trends by analyzing 237 abstracts in the field of swine nutrition and feed published by Korean researchers from 2023 to 2025. The abstracts were classified into eight research categories. Among them, functional feed additives accounted for the largest proportion (18.6%), followed by energy, amino acid, and digestibility prediction (16.9%). Other/integrated studies, including ICT, AI, and animal welfare, accounted for 14.8%, followed by gut microbiota and omics-based mechanistic studies (13.9%), low-protein diets, precision nutrition, and nitrogen reduction (11.8%), sow and piglet nutrition management (9.3%), environmental impact, odor, and manure reduction (7.6%), and feed ingredient evaluation (7.2%). These results indicate that recent swine nutrition research in Korea has mainly focused on evaluating functional feed additives and precisely estimating the nutritional value of feed ingredients, while expanding toward microbiome research, omics-based approaches, environmental impact reduction, and smart feeding management. The findings of this study may provide basic information for selecting future research topics and applying research outcomes to the swine industry.

Key words : swine nutrition, feed additives, nutrient digestibility, gut microbiota, research trend analysis

Characterization and bioactive potential of oils from edible and industrial feed-grade insects

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Insects are recognized as sustainable bioresources, with their protein being widely utilized while the lipid fraction remains typically discarded. This study evaluated the extraction yields, color profiles, and bioactive potential of oils from five edible species (*Tenebrio molitor*, *Zophobas atratus*, *Protaetia brevitarsis*, *Gryllus bimaculatus*, *Bombyx mori*) and one feed-grade species (*Hermetia illucens*). To ensure gut clearance, insects were starved for 24–48 hours, hot-air dried, and oils were extracted using a screw press at 120°C. *H. illucens* exhibited the highest oil yield (27.8%), followed by *Z. atratus* (25%) and *T. molitor* (21%). Bioactive screening (1.58–25%) revealed that total flavonoid and phenolic contents, along with antioxidant activities (ABTS/DPPH), increased dose-dependently, while nitric oxide production was significantly inhibited. *H. illucens*, *Z. atratus*, and *T. molitor* are identified as efficient oil sources with superior yields and potent anti-inflammatory efficacy at non-cytotoxic levels, making them ideal for functional feed additives. While *G. bimaculatus* and *B. mori* showed moderate yields and unique chromaticity suitable for specialized biomedical niches, *P. brevitarsis* exhibited low oil yield and limited bioactivity, suggesting that prioritizing its protein fraction is more economically advantageous. These findings provide a strategic framework for upcycling insect lipids, transforming discarded byproducts into high-value functional bioresources for animal nutrition and biomedical applications.

Key words : edible Insect, Industrial feed-grade insect, insect Oil, *Tenebrio molitor*, *Zophobas atratus*, *Hermetia illucens*

Impact of intravaginal lactic acid administration on sow body condition indices and piglet growth after farrowing

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This study investigated the effects of intravaginal lactic acid (LA) administration on sow body condition indices and piglet growth performance after farrowing under heat stress (HS). A total of 40 LY lactating sows were assigned to treatments in a 2×2 factorial arrangement: thermoneutral (TN) or heat stress (HS) conditions, with 0%, 0.1%, or 0.3% intravaginal LA administration. Heat stress significantly reduced average daily feed intake (ADFI; 6.44 vs. 5.79 kg/d, $p < 0.05$), whereas LA administration tended to improve ADFI in HS sows (6.07 and 6.24 kg/d for 0.1% and 0.3% LA, respectively; $p = 0.026$). Litter weight at weaning was significantly lower in HS sows (52.64 vs. 60.15 kg; $p < 0.05$), and piglet average daily gain was reduced under HS (0.207 vs. 0.221 g/d; $p < 0.05$). LA administration showed numerical improvements in litter weight at weaning (54.70 and 56.79 kg for 0.1% and 0.3% LA). Body weight, backfat thickness, and litter size at birth were not significantly affected by temperature or LA administration. These findings suggest that LA administration may partially mitigate the negative effects of heat stress on feed intake and litter performance in lactating sows.

Key words : heat stress, lactating sows, organic acid, body condition, lactating performance

Effects of probiotic feeding on productivity, immune system, and viral antibody titer in piglets after porcine reproductive and respiratory syndrome infection

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Previous studies have shown that feeding probiotics to piglets increases productivity and that serum analysis revealed significantly higher values in the probiotic-fed group, indicating that probiotics influence the immune system of pigs. This study was conducted to investigate the effects of probiotics on productivity, the immune system, and viral antibody titers following infection with Porcine Reproductive and Respiratory Syndrome Virus (PRRSV), a major disease in pigs. The experiment was conducted by dividing 56-day-old pigs, fed a control group, commercial probiotics, and two types of proprietary probiotics for 28 days, into four groups of 10 (CTR, CMP, JB, and VET); five pigs were infected with PRRSV, and five were normal. Regarding pig productivity, changes in average daily body weight and daily weight gain were analyzed. Serum indicators were analyzed to examine changes in the immune system, and Enzyme-Linked Immunosorbent Assay (ELISA) and real-time quantitative PCR (RT-qPCR) were performed to assess changes in PRRSV antibody titers. Among the PRRSV-infected groups, average body weight and daily gain were higher in the probiotic-fed group; conversely, between the PRRSV-infected group and the normal group, no significant difference was found in daily gain in the CMP probiotic group. Serum analysis results showed higher levels of neutrophil (Neu) and Total Protein (TP) in the probiotic-fed group compared to the control group, indicating enhanced immunity against the virus; however, the ELISA and RT-qPCR results did not show significant differences. Overall, the results indicated that feeding probiotics to piglets infected with PRRSV improved productivity and immunity.

Key words : PRRSV, probiotic, ELISA, RT-qPCR

Changes in fecal organic acid profiles and odor-related indicators following dietary supplementation with *Latilactobacillus curvatus* CACC879 in finishing pigs

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This study evaluated the effects of dietary supplementation with *Latilactobacillus curvatus* CACC879 on fecal fermentation-related characteristics, odor-related indicators, and fecal microbiota in finishing pigs. A total of 60 finishing pigs were used in a 10-week feeding trial and assigned to either a basal diet or the basal diet supplemented with *L. curvatus* CACC879 at 0.25% (1.2×10^{10} CFU/g). Growth performance, nutrient digestibility, and fecal score were measured, and fecal samples collected from 10 pigs per treatment were used for 16S rRNA gene-based microbiota analysis, organic acid quantification, and fecal slurry malodor analysis. Dietary supplementation with *L. curvatus* CACC879 did not significantly affect growth performance or fecal score, although energy digestibility tended to increase. The supplemented group showed higher concentrations of butyric acid, propionic acid, valeric acid, isobutyric acid, isovaleric acid, and 2-methylbutyric acid, together with lower fecal slurry concentrations of hydrogen sulfide and methyl mercaptan. Microbiota analysis showed limited differences at the overall community level, but treatment-associated genus-level changes were observed at week 10. These results indicate that *L. curvatus* CACC879 may improve fermentation-related and odor-associated outcomes in finishing pigs without compromising productive performance.

Key words : *Latilactobacillus curvatus*, fecal microbiota, malodor, sulfur compounds, probiotics

Effects of dietary dehydrated alfalfa hay supplementation on body condition and reproductive performance in late-gestating sows

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This study was conducted to investigate the effects of dietary dehydrated alfalfa hay supplementation during late gestation on body condition and reproductive performance in sows. A total of 27 Yorkshire × Landrace crossbred pregnant sows were assigned to a completely randomized design with three dietary treatments: T1, basal diet (control); T2, 5% dehydrated alfalfa hay inclusion; and T3, 10% dehydrated alfalfa hay inclusion ($n = 9$ per treatment). Sows were fed experimental diets from day 80 of gestation to farrowing. Body weight and backfat thickness were measured at day 80 and 110 of gestation, and at farrowing. Reproductive parameters including litter size, litter weight, individual piglet birth weight, number of piglets weaned, and weaning weight were recorded. Data were analyzed by one-way ANOVA using the general linear model (GLM) procedure of SAS, and treatment means were separated by Duncan's multiple range test. Significance was declared at $p < 0.05$. Results showed that dietary dehydrated alfalfa hay supplementation significantly increased gestational body weight gain ($p < 0.05$), with values of 8.0, 14.3, and 20.0 kg for T1, T2, and T3, respectively, indicating a significant linear response to inclusion level. However, no significant differences were observed in backfat thickness change among treatments. Litter size, litter weight, individual piglet birth weight, number of piglets weaned, and weaning weight were not affected by dehydrated alfalfa hay inclusion ($p > 0.05$). In conclusion, dietary supplementation with up to 10% dehydrated alfalfa hay during late gestation effectively enhanced gestational weight gain without adverse effects on reproductive performance, suggesting its potential as a nutritional strategy for improving sow body condition in late gestation.

Key words : dehydrated alfalfa hay, late gestation sow, body condition, reproductive performance

Prediction equations for *in vitro* nutrient disappearance of tropical plant-derived ingredients from Vietnam in pigs

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The objectives were to determine *in vitro* total tract disappearance (IVTTD) of nutrients in tropical plant-derived ingredients and to develop prediction equations for IVTTD of dry matter (DM) and organic matter (OM) using their chemical composition for pigs. Nine tropical ingredients (pineapple peel, dragon fruit peel, passion fruit peel, banana peel, mangosteen peel, wild daisy leaves, white leadtree leaves, cassava leaves, and green tea leaves) were analyzed for chemical composition. The IVTTD of nutrients in 9 ingredients were determined using a 3-step *in vitro* procedure. The ash and lignin contents ranged from 2.9% to 12.6% and from 2.5% to 28.4%, respectively. The IVTTD of DM and OM in dragon fruit peel were the greatest (79.6% and 78.9%; $p < 0.05$) among 9 ingredients. The IVTTD of DM and OM was positively correlated with ash ($r > 0.73$; $p < 0.05$) whereas negatively correlated with lignin ($r < -0.79$; $p < 0.01$). The prediction equations for IVTTD of DM and OM were: IVTTD of DM = $58.78 - 1.19 \times \text{lignin} + 2.21 \times \text{ash}$ ($R^2 = 0.881$; $p < 0.001$), and IVTTD of OM = $55.48 - 0.83 \times \text{lignin} + 2.37 \times \text{ash} - 1.08 \times \text{ether extract}$ ($R^2 = 0.919$; $p = 0.001$). All chemical compositions in test ingredients were expressed on % as-is basis. In conclusion, the IVTTD of DM and OM for pigs varies among the tropical plant-derived ingredients and can be estimated based on ash and lignin.

Key words : *in vitro* nutrient disappearance, lignin, prediction equation, tropical plant-derived ingredients

Effects of environment temperature on reproductive performance, piglet growth, and colostrum composition in first parity sows

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This study investigated the effects of environment temperature on reproductive performance, piglet growth, and colostrum composition in first-parity sows. A total of 28 sows were randomly assigned to either termoneutral (TN) or heat stress (HS) conditions. The TN condition was maintained at approximately 24°C using air conditioning, whereas the HS condition was maintained at approximately 30°C using heaters. The experimental temperatures were maintained from 5 days from 5 days after into the farrowing room until weaning. Average daily feed intake (ADFI) during lactation was significantly lower in HS sows than in TN sows (4.44 vs. 5.48 kg/d; $p = 0.001$). However, no significant differences were observed in body weight or backfat thickness at the initial or weaning periods between the two groups. Litter size parameters, including total born, stillbirths, born alive, and number of piglets weaned, were not significantly affected by treatment. Similarly, litter weight, piglet birth weight (1.37 vs. 1.43 kg), weaning weight (5.63 vs. 6.00 kg), and average daily gain (0.20 vs. 0.22 kg/day) did not differ significantly between the HS and TN groups. Placental weight and placental efficiency were also not affected by heat stress. Regarding colostrum characteristics, colostrum yield (3.76 vs. 4.25 kg) and all compositional parameters, including fat, protein, lactose, and total solids, showed no significant differences between the HS and TN groups. In conclusion, although heat stress significantly reduced feed intake during lactation, it did not markedly impair reproductive performance, piglet growth, or colostrum composition in first-parity sows under the conditions of this study.

Key words : heat stress, sow, reproductive performance, colostrum, piglet growth

Intestinal microbiome characteristics of piglets classified by early growth performance

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This study aimed to characterize gut microbial profiles associated with growth performance in piglets using full-length 16S rRNA sequencing. Piglets were classified into robust and non-robust groups based on average daily gain (ADG) at 4 weeks of age, and 25 animals were selected for each group at 8 weeks of age based on body weight. Digesta samples were collected from the jejunum, ileum, cecum, and colon. No significant differences in alpha- or beta-diversity were observed between groups across intestinal regions. Exploratory differential abundance analysis using the top and bottom five piglets based on body weight identified several gut microbial taxa showing compositional differences between groups. In particular, the *Ruminococcus*-related group and *Catenibacterium* showed relatively greater abundance in the cecum and colon, whereas *Olsenella* showed greater abundance in the colon of heavier piglets. These findings suggest that specific gut microbial taxa may be associated with growth-related phenotypes in piglets and provide preliminary insight into microbial candidates linked to piglet robustness.

Key words : piglet, microbiome, ADG

In vitro nutrient disappearance can be predicted using fiber contents in fibrous ingredients for pigs

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The objective was to develop prediction equations for *in vitro* nutrient disappearance of various fiber sources for pigs using chemical composition. *In vitro* assay was employed to determine *in vitro* total tract disappearance (IVTTD) of dry matter (DM) and organic matter (OM). Six fibrous ingredients were used: defatted rice bran, wheat bran, sugar beet pulp, soybean hulls, corn cobs, and sawdust. Amylase-treated neutral detergent fiber (aNDF) contents in test ingredients ranged from 26.1% in defatted rice bran to 89.8% in sawdust, acid detergent fiber (ADF) ranged from 9.3% to 73.6%, and insoluble dietary fiber (IDF) ranged from 22.5% to 88.7%. The IVTTD of DM and OM in sugar beet pulp was greatest ($p < 0.05$) among the 6 fiber sources, followed by defatted rice bran, wheat bran, soybean hulls, corn cobs, and sawdust. The IVTTD of OM was negatively correlated with aNDF ($r = -0.94$; $p < 0.01$), ADF ($r = -0.82$; $p < 0.05$), and IDF ($r = -0.87$; $p < 0.05$). The equations for predicting the IVTTD of OM in fibrous ingredients based on fiber contents were: IVTTD of OM (%) = $113.74 - 1.20 \times \text{aNDF}$ with $r^2 = 0.89$; IVTTD of OM (%) = $84.79 - 1.11 \times \text{ADF}$ with $r^2 = 0.68$; IVTTD of OM (%) = $110.00 - 1.09 \times \text{IDF}$ with $r^2 = 0.75$ (all variables are based on % as-is). In conclusion, the IVTTD of OM can be predicted using fiber contents in fibrous ingredients for pigs.

Key words : fiber sources, *in vitro*, nutrient, swine

Determinants of piglet survival from birth to weaning: a comprehensive review

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Pre-weaning piglet mortality has turned out to be a major concern in modern swine operations. To keep up with enhanced piglet welfare and economic viability, a comprehensive understanding of the factors influencing piglet survival rate is essential. This review paper examines the factors affecting piglet survival and discusses the latest advancements in technology and research aimed at improving survival rates. Through an extensive analysis of relevant literature and research studies across major databases, extracted data were analysed and graphically represented. Data from the studied literature showed a relatively higher heritability for piglet birth weight, indicating genetic selection could improve survivability. For the sake of statistical comparison, piglet birth weight, a major determinant of survivability, was classified into five categories. It was found to have 24%, 62.15%, 89.70%, 90.63% and 97% of piglet pre-weaning survivability with the birth weight categories of < 0.7 kg, < 1.1 kg, ≥ 1.1 kg, > 1.6 kg, and ≥ 2.40 kg, respectively. For other traits like stillborn, mummified piglet, survival to day 5, and pre-weaning mortality, the heritability estimates are low, indicating these are more influenced by management and environment. So, genetic selection for higher birth weight (≥ 1.1 kg) and improved nutrition, housing, and farrowing supervision are recommended after evaluating the existing data.

Key words : piglets, colostrum intake, birth weight, pre-weaning mortality, pre-weaning survivability

Dietary antioxidants and postbiotics modulate the gut microbiota-redox axis in broiler chickens: implications for intestinal health, growth performance and meat quality

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Modern broiler production exposes birds to nutritional, environmental, and biological stressors that promote oxidative stress, intestinal dysfunction, reduced growth efficiency, and deterioration of meat quality. This review examines the conceptual basis of this axis in broiler chickens, including microbiota development, common biomarkers of redox homeostasis, tight-junction disruption, and the signaling pathways that connect intestinal oxidative stress with whole-bird outcomes. It then critically evaluates major stressors that destabilize this system and the roles of dietary antioxidants and postbiotics as complementary nutritional interventions. Across heat stress, high stocking density, oxidized lipids, mycotoxins, lipopolysaccharide challenge, and enteric disease models, these interventions have been associated with improved antioxidant status, modulation of Nrf2/Keap1 and inflammatory pathways, preservation of intestinal morphology and tight-junction function, and favorable shifts in microbial composition and metabolite production, particularly short-chain fatty acids. These gut-level effects can translate into better nutrient utilization, feed efficiency, growth performance, and meat oxidative stability. However, current evidence remains heterogeneous with respect to experimental models, biomarker panels, microbiome methods, product characterization, and the definition of postbiotics.

Key words : broiler chickens, gut microbiota, oxidative stress, redox homeostasis, dietary antioxidants

Audio-based artificial intelligence for respiratory health and welfare monitoring in broiler chickens

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Respiratory diseases and welfare impairments impose economic and ethical burdens on broiler production, driven by high stocking density, rapid pathogen transmission, and limited sensitivity of conventional monitoring. Because respiratory pathology and stress alter vocal behavior, acoustic monitoring has emerged as a non-invasive tool for flock-level surveillance. This manuscript synthesizes the anatomical basis of sound production in broilers, key vocal categories related to health and welfare, and recording strategies, datasets, acoustic features, machine-learning and deep-learning models, and evaluation metrics in poultry sound analysis. Evidence indicates that broilers are especially vulnerable to respiratory stress at early and late production stages; respiratory sounds such as coughing, sneezing, and rales are mainly associated with disease, while distress calls and silence patterns inform welfare and environmental interpretation. Advanced deep-learning and transformer-based models can outperform classical machine-learning approaches, especially with optimized feature-model combinations. Overall, AI-based acoustic systems can detect respiratory sounds, stress, and welfare changes and support earlier intervention. However, noise, data imbalance, limited multi-farm validation, interpretability, and deployment challenges remain barriers to wider application.

Key words : broiler chickens, respiratory disease, acoustic monitoring, artificial intelligence, animal welfare

Effects of dietary *Salmonella*-specific bacteriophage supplementation in broiler chickens

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The present study investigated the antibacterial effects of *Salmonella*-specific bacteriophages and their influence on gut(intestinal) health in broiler chickens challenged with *Salmonella Typhimurium*. Prior to the feeding trial, bacteriophage L and bacteriophage B were evaluated for lytic activity against *Salmonella gallinarum* and *Salmonella enteritidis* using agar plate assays, where clear antibacterial activity was confirmed. A total of 960 one-day-old Arbor Acres broilers were assigned to 12 treatment groups in a 2 × 6 factorial design based on challenge status and dietary treatment. Birds were orally inoculated with *S. Typhimurium* at 4 days of age and fed experimental diets for 35 days. As expected, *Salmonella* challenge negatively affected growth performance and increased mortality ($p < 0.05$). Dietary treatments did not markedly influence overall growth performance. However, birds receiving bacteriophage supplementation showed lower cecal *Salmonella* counts at day 28 and improved villus height and villus height-to-crypt depth ratio at day 32 ($p < 0.05$). In addition, several cecal volatile fatty acid parameters were affected by the interaction between *Salmonella* challenge and dietary supplementation. Overall, the results suggest that dietary bacteriophage supplementation could help reduce intestinal *Salmonella* colonization and support gut health in broiler chickens under *Salmonella* challenge conditions.

Key words : bacteriophage, *Salmonella Typhimurium*, broiler, gut health

A comprehensive review of bump-feeding strategies during late gestation in sows: nutritional and behavioral implications for farrowing performance and reproductive outcomes

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Bump feeding is a late-gestation nutritional strategy that increases feed allowance or nutrient density, usually from day 90 to farrowing, to support fetal growth and prepare sows for lactation. This review summarizes current evidence on the effects of bump feeding on sow body condition, feeding behavior, farrowing outcomes, and piglet viability. Previous studies suggest that increased late-gestation feed intake may improve litter characteristics, piglet survival, and sow energy reserves, as reflected by backfat thickness and body condition score. However, responses vary depending on dietary energy, amino acid balance, parity, and sow feeding behavior. Inconsistent findings remain, particularly regarding reproductive benefits versus excessive fat deposition. Optimized parity-specific bump-feeding strategies are needed to improve farrowing performance, piglet survival, sow welfare, and production efficiency.

Key words : bump feeding, late gestation, piglet birth weight, feeding behavior, backfat thickness

Effects of dietary co-contamination of deoxynivalenol and fumonisin B1 on growth performance and fecal microbiota in weaned piglets

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Mycotoxin contamination in feed, particularly deoxynivalenol (DON) and fumonisin B1 (FB1), is a major concern in swine production as these toxins negatively affect gut health. This study evaluated the effects of combined DON and FB1 exposure on growth performance and fecal microbiota in weaned piglets. A total of 15 male piglets were assigned to five treatments with three pigs per group for 4 weeks: Control (CON), T1 (DON 0.1 ppm + FB1 0.1 ppm), T2 (DON 0.1 ppm + FB1 4 ppm), T3 (DON 4 ppm + FB1 0.1 ppm), and T4 (DON 4 ppm + FB1 4 ppm). Fecal samples collected at the end of the experiment, and fecal microbiota was analyzed using 16S rRNA sequencing. T4 showed the lowest final body weight and average daily gain, as well as the highest feed conversion ratio among treatments ($p < 0.05$). Fecal microbial composition differed among treatments based on beta-diversity analysis ($p = 0.018$). *Spirochaetota* was predominant in T4 ($p = 0.047$), while *Prevotella* abundance increased under high FB1 exposure ($p = 0.037$). In contrast, *Roseburia hominis* was most abundant in CON ($p = 0.042$). Carbohydrate metabolism pathways, including galactose metabolism ($p = 0.043$) and starch/sucrose metabolism ($p = 0.029$), were enriched in CON compared with mycotoxin-treated groups. These results suggest that dietary DON and FB1 co-contamination negatively affected growth performance and altered fecal microbiota and metabolic functions in weaned piglets.

Key words : deoxynivalenol, fumonisin B1 fecal microbiota, growth performance, weaned piglets

Nutritional evaluation and *in vitro* digestibility of novel feed ingredients for swine diets

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This study evaluated the nutritional composition and *in vitro* digestibility of four novel by-product feed ingredients ramen by-product (RBP), spent mushroom substrate (SMS), black soldier fly larvae (BSFL), and cabbage (CAB) as potential alternatives in swine diets. Dry matter (DM), organic matter (OM), gross energy (GE), and ether extract (EE) were analyzed, and *in vitro* digestibility was assessed using a two-step enzymatic method (Boisen & Fernandez, 1997; pepsin followed by pancreatin, $n = 6$). Nutritional composition differed significantly among ingredients, with BSFL showing the highest GE and EE, and CAB the highest OM content. *In vitro* digestibility ranked BSFL > RBP > CAB $\geq$ SMS across all measured parameters ($p < 0.05$). In a second experiment, RBP and SMS were included as partial corn replacements at 5, 7.5, and 10% levels in complete piglet diets. DM, OM, and EE digestibility were not significantly affected by either ingredient or inclusion level ($p > 0.05$), whereas GE digestibility was affected by SMS inclusion level ($p < 0.05$). These results suggest that RBP and SMS can partly replace corn without substantially reducing *in vitro* digestibility, supporting their potential as cost-effective and domestically available feed ingredients for swine production, and further *in vivo* studies are needed to confirm their practical nutritional value.

Key words : novel feed ingredients, swine diets, *in vitro*, nutrient digestibility

Effects of fat content and aging time on flavor precursors and volatile flavor compounds in beef

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Minced round aged for 3 days and 14 days was blended with 0%, 5%, 10%, 15%, and 20% back fat to create mixed meat preparations. This investigated material changes during aging and the effect of fat content on the formation mechanism of volatile flavor compounds in Hanwoo beef. Gas Chromatography–Mass Spectrometry (GC-MS) was used to analyze the fatty acid composition, metabolites, and volatile flavor compounds in the meat mixtures, while ultra-high-performance liquid chromatography (UHPLC) was employed to detect free amino acids. Results showed that the 14-day aged round meat contained higher abundances of amino acids, sugars, fatty acids, and organic acid metabolites compared to the 3-day aged round meat. The 14-day aged round meat blended with backfat sample exhibited 17 additional detected aroma compounds, primarily aldehydes (e.g., Hexanal, Heptanal), ketones, furans, and pyrazines, with aldehydes being the main differentiating variable. PCA and PLS-DA clearly distinguished flavor compounds in blended meat mixtures with varying backfat ratios. Key differential variables included hexanal, octanal, heptanal, 2-butanone, furan, and 2-pentyl-based compounds across different backfat sample groups. Fatty acid analysis revealed changes in unsaturated fatty acids during aging. Adding back fat increased the ruminant fatty acid spectrum (C15:0, C17:0) characteristics in the minced meat's fatty acid composition. Spearman correlation analysis between fatty acids and flavor compounds indicated that C17:1n7, C20:1n9, C12:0, C14:0, C15:0, C16:1n7, and C14:1n5 showed significant correlations ($p < 0.05$) with flavor compounds such as Butanal, 3-methyl-, 2-Butanone, Butanal, 2-methyl-, 1-Pentanol, Hexanal, Pentanal, and 2,3-Butanedione. The increased fat content produces a simple dilution effect and increases lipid oxidation substrates, thereby altering the formation pathways of volatile flavor compounds. The aging process increases the content of protein, carbohydrates, and nucleic acid precursors, while butter increases the content of lipid precursors. These two factors together contribute to the different flavor profiles of cooked beef. Furthermore, volatile flavor characteristics also reflect these biochemical changes.

Key words : Hanwoo beef, aging, backfat, volatile flavor components

Validation of the prediction model for estimating gross energy concentrations of pig urine using Brix value

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Determination of metabolizable energy of swine feeds requires an analysis of urinary gross energy (GE). A prediction equation for estimating GE of pig urine based on Brix value: urinary GE (kcal/kg) = $11.96 \times \text{Brix (\%)} + 2.33$ ($r^2 = 0.87$; $p < 0.001$). However, the prediction equation has not been validated. Therefore, the present study aimed to validate the prediction equation using pig urine samples that were not used for developing the equation. A total of 117 urine samples from pigs were analyzed for GE concentrations using an adiabatic bomb calorimeter and Brix values using a digital refractometer. The measured GE concentrations of the urine samples ranged from 12.9 to 172.4 kcal/kg and Brix values ranged from 1.1% to 12.0%. The predicted GE concentrations of the urine samples were calculated using the equation with measured Brix value. A regression analysis was performed for measured GE minus predicted GE on predicted GE minus average of predicted GE. The intercept was 1.68 (standard error = 1.66; $p = 0.315$), indicating that there was no mean bias. The slope was 0.102 (standard error = 0.065; $p = 0.117$), indicating that there was no linear bias. Therefore, urinary GE concentrations in pigs can be fairly well estimated using the previously developed prediction equation based on Brix value.

Key words : Brix, gross energy, swine, urine, validation

Gene set enrichment-based reanalysis of hepatic transcriptomic responses to feed restriction and refeeding in pigs differing in birth weight

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This study reanalyzed a publicly available hepatic transcriptome dataset to characterize pathway-level responses to early postnatal feed restriction and subsequent refeeding in pigs differing in birth weight (BW). Normal-BW (N) and low-BW (U) pigs were compared between control-fed (K) and feed-restricted (R) groups at day 98, immediately after restriction, and day 131, after five weeks of refeeding. Gene Set Enrichment Analysis was performed for Gene Ontology biological process, cellular component, and molecular function categories, with adjusted $p < 0.05$ considered significant. At day 98, NK versus NR showed 125 biological process, 99 cellular components, and 45 molecular function terms, involving ribosome biogenesis, rRNA processing, preribosome, and catalytic activity acting on RNA. UK versus UR showed broader enrichment, with 282 biological process, 67 cellular component, and 80 molecular function terms. In low-BW pigs, restriction-associated terms included rRNA metabolic process, ribosome biogenesis, mitotic sister chromatid segregation, mitotic spindle organization, and chromosomal region, suggesting coordinated regulation of RNA metabolism, translational capacity, and cell-cycle processes. At day 131, significant terms were greatly reduced, with four biological process terms in NK versus NR and one protein folding term in UK versus UR. These findings indicate that feed restriction induces acute hepatic transcriptomic remodeling, particularly in low-BW pigs, while most pathway-level signals are attenuated after refeeding, providing insight into compensatory growth mechanisms and BW-dependent nutritional programming in the juvenile swine liver during the postnatal development period.

Key words : pig, birth weight, feed restriction, liver transcriptome, GSEA, compensatory growth

반려동물 사료와 동물성 원료의 칼슘·인 분석 정확도 향상을 위한 ICP-OES 파장 조건 비교 연구

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반려동물은 사람과 달리 다양한 식품 섭취를 통한 영양 보완이 제한적이며, 주식인 사료를 통해 필수 영양소가 균형 있게 공급되어야 한다. 특히 칼슘(Ca)과 인(P)은 골격 형성, 대사 및 생리 기능 유지에 핵심적인 무기질로, 함량뿐 아니라 상호 비율 또한 매우 중요하다. 이에 따라 AAFCO는 반려동물 사료 내 칼슘과 인의 비율을 1:1-2:1 범위로 권장하고 있다. 따라서 사료의 영양학적 품질 평가를 위해서는 칼슘과 인 분석의 정확성과 재현성을 확보하는 것이 필수적이다. 이러한 칼슘과 인을 분석하는 ICP-OES는 다원소 및 다파장 동시 분석이 가능한 장비로, 적은 시료량으로 짧은 시간 내 정성 및 정량 분석이 가능하다는 장점이 있다. 그러나 장비 구성, 분광 특성, 적용 파장에 따라 동일 시료에서도 결과값의 편차가 발생할 수 있다. 특히 칼슘과 인은 원소 특성상 파장 선택에 따른 감도 및 간섭 영향이 크며, 분석 조건에 따라 결과 재현성이 달라질 수 있다. 또한 반려동물 사료의 주요 원료인 육분과 같은 동물성 원료는 골 함량 및 회분 조성 변동성이 크기 때문에 칼슘과 인 함량 또한 변동성이 크다. 따라서 ICP-OES 분석 시에는 여러 파장을 비교하여 특성을 분석하고 가장 대표적인 파장을 선정하는 것이 중요하다. 본 연구에서는 반려동물 사료와 동물성 원료를 대상으로 칼슘과 인의 ICP-OES 분석을 수행하고, 파장 조건 별 편차를 비교 후, 원료에 따른 변동성을 평가하였다. 이를 통해 반려동물 사료의 칼슘 및 인 분석 시 발생 가능한 주요 편차 요인을 확인하여, 분석 정확성과 재현성을 확보하였다.

Key words : ICP-OES, 칼슘, 인, 반려동물 사료, 동물성원료