TEK-MAX

Key Technologies for the Application of Low-protein, Low-soybean-meal Diets in Swine Feeds

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Xi'an

Content

- Basic Research
- Basic Application
- Basic Opperation

Basic Research

Basic Nutrition for Pigs

- **NE/ME/DE**
- **AA: Lys/Met/Thr/Trp/Val**
  - **SID AA**
  - **source**
- **Ca/P**
- **Mineral: Cr/Se/Zn/Cu…**
- **NDF**
- **CP**

Low-protein Technology/Ideal Amino Acid Pattern

TEK-MAX

- **Basic Research:**
  - **Maintenance of Amino Acid Ratios:** (D. H. Baker, 1966)
  - Concept was introduced by ARC (1981)
  - **Protein Deposition Amino Acid Ratios:** (M. F. Fuller 1989)
    - **Low Crude Protein-Optimum Dietary AA Pattern**(M. F. Fuller 1989)
  - **Ideal AA Pattern** (D. H. Baker, 1992)
  - **Dynamic Ideal Protein** (S. W. Kim, 2001)
  - **H. T. Yen:** Difference in rates of net portal absorption between crystalline and protein-bound
  - K. De Lange, J. E. Pettigrew: **AA mathematic model**
- Applied Research:
  - **Gary L Allee, L. L. Southern**
  - **KSU, CAU**
  - **Industrial Production of Synthetic Amino Acids**

Dynamic AA Model: An Ideal Amino Acid Model for Limiting Amino Acids in Lactating Sows

体重损失 Estimated 21 d weight loss (kg)	70~80	33~45	12~15	6~8	0	0~7
组织动员程度 Level of tissue mobilization,% [2]	50	40	20	5	0	NRC 1998 [3]
理想氨基酸模型 Ideal amino acid pattern (% of lysine)						
赖氨酸 Lysine	100	100	100	100	100	100
苏氨酸 Threonine	75	69	63	60	59	62
缬氨酸 Valine	78	78	78	77	77	85
亮氨酸 Leucine	128	123	118	115	115	114
异亮氨酸 Isoleucine	60	59	59	59	59	56
精氨酸 Arginine	22	38	59	69	72	56
限制性氨基酸的顺序 Order of limiting amino acids [4]						
第一限制性 First	Thr	Lys	Lys	Lys	Lys	Lys
第二限制性 Second	Lys	Thr	Thr	Val	Val	Val
第三限制性 Third	Val	Val	Val	Thr	Thr	Thr

注：[1] 来源：Kim 等（2001）。 [1] Source: Kim, etc

[2] 数值表示来自母猪体动员氨基酸在乳氨基酸中的比例。 [2] Values indicate the proportion of amino acids from sow body mobilization in milk amino acids

[3] NRC（1998）没有考虑体组织蛋白动员。 [3] NRC does not consider somatic histone mobilization

[4] 假设哺乳期饲喂典型的玉米-豆粕型日粮（0.90%）。 [4] Assuming typical corn-soybean meal type diets are fed during lactation(0.90%)

Protein in Mammary Gland

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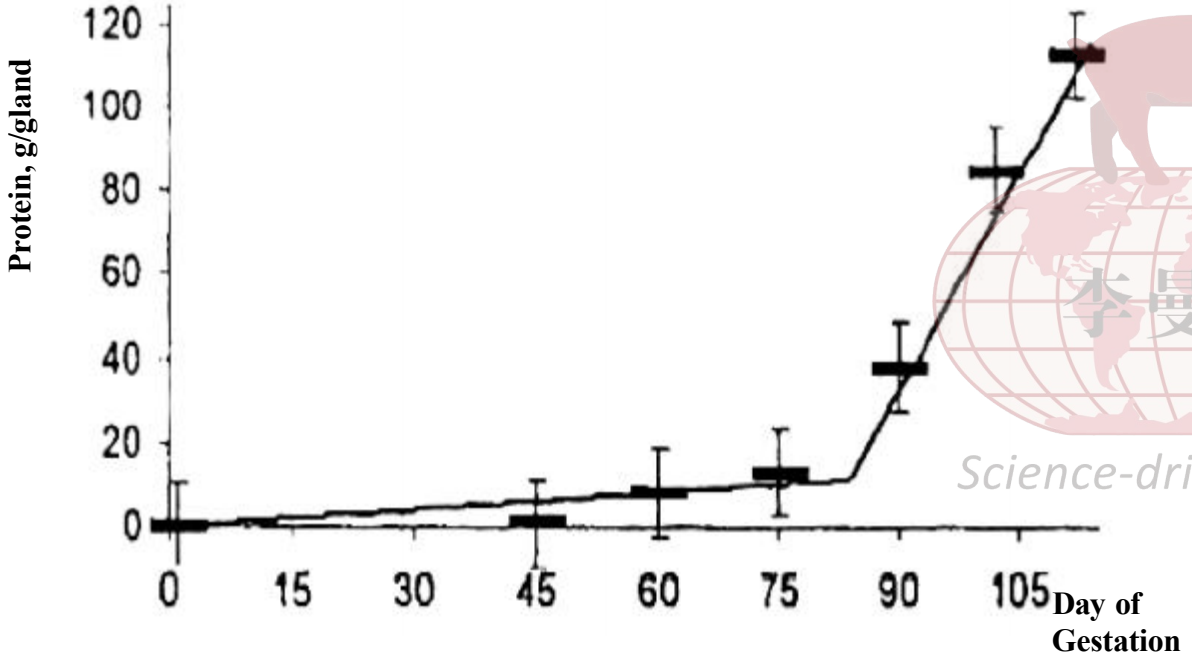
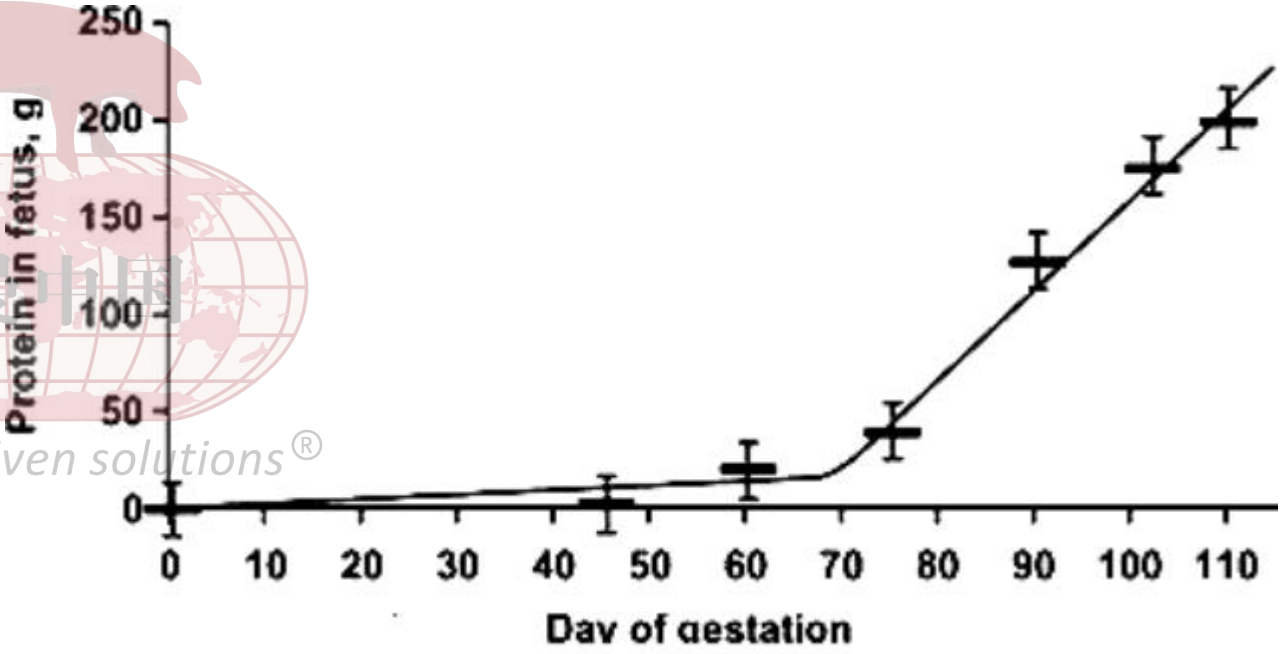
Fetal Protein Accretion



Ji, 2004



McPherson et al., 2004

Starch's Difference

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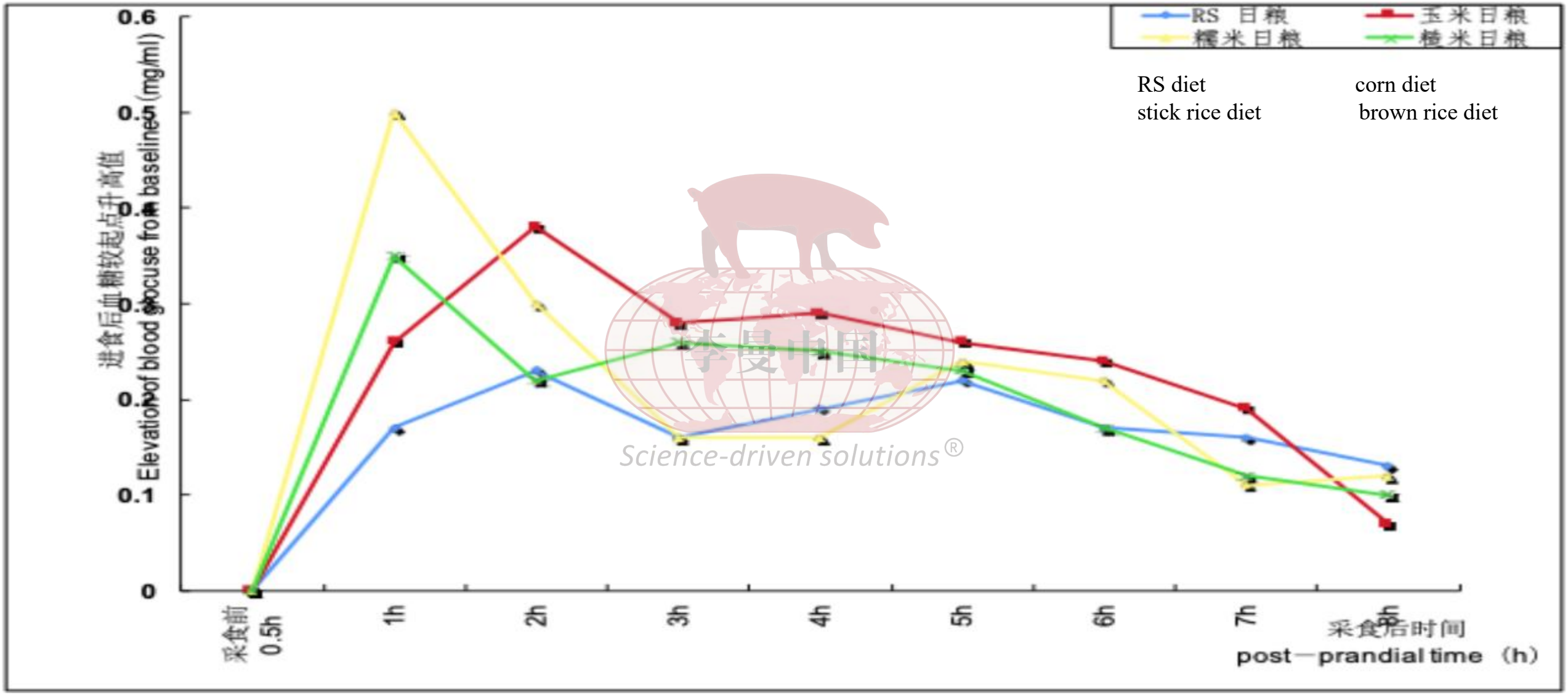

Qiuzhong Dai, 2005

Effects of starch on AA TID

Amino acids	RS diet	Maize diet	Brown rice diet	Stick rice diet
Asp	81.10±2.68^{b}	88.86±2.40^{ab}	92.95±2.40^{a}	89.05±2.68^{ab}
Glu	82.13±2.27^{b}	89.39±2.03^{a}	94.00±2.03^{a}	91.70±2.27^{a}
Ser	68.81±2.17^{b}	80.49±1.94^{a}	85.85±1.94^{a}	79.63±2.17^{a}
His	74.38±2.80^{c}	89.98±2.50^{b}	96.21±2.50^{ab}	103.42±2.80^{a}
Gly	79.22±4.15	76.26±3.71	83.90±3.71	72.47±4.15
Thr	76.16±2.71 ^{b}	82.10±2.42 ^{ab}	87.18±2.42 ^{a}	81.35±2.71 ^{ab}
Arg	80.77±2.03 ^{b}	93.45±1.81^{a}	93.60±1.81^{a}	91.57±2.03^{a}
Ala	78.48±2.87	79.62±2.57	81.14±2.57	72.84±2.87
Tyr	80.04±2.42 ^{b}	92.79±2.17^{a}	91.56±2.17^{a}	85.79±2.70^{ab}
Meth	74.49±2.15^{b}	96.21±1.92^{a}	95.54±1.92^{a}	91.18±2.15^{a}
Val	75.91±3.41	84.43±3.05	86.01±3.05	79.44±3.41
Phe	80.36±2.48 ^{b}	87.87±2.22 ^{a}	89.57±2.22 ^{a}	86.43±2.48 ^{a}
Ile	70.22±2.48^{b}	86.38±2.22^{a}	88.32±2.22^{a}	82.38±2.48^{a}
Leu	81.06±2.04^{b}	88.92±1.82^{a}	89.75±1.82^{a}	85.38±2.04^{ab}
Lys	70.69±2.57^{b}	90.43±2.30^{a}	89.58±2.30^{a}	88.62±2.57^{a}
TAA	76.88±2.25^{b}	86.99±2.01^{a}	89.94±2.01^{a}	85.25±2.25^{a}

Qiuzhong Dai, 2005

Differences in Amino Acid Absorption

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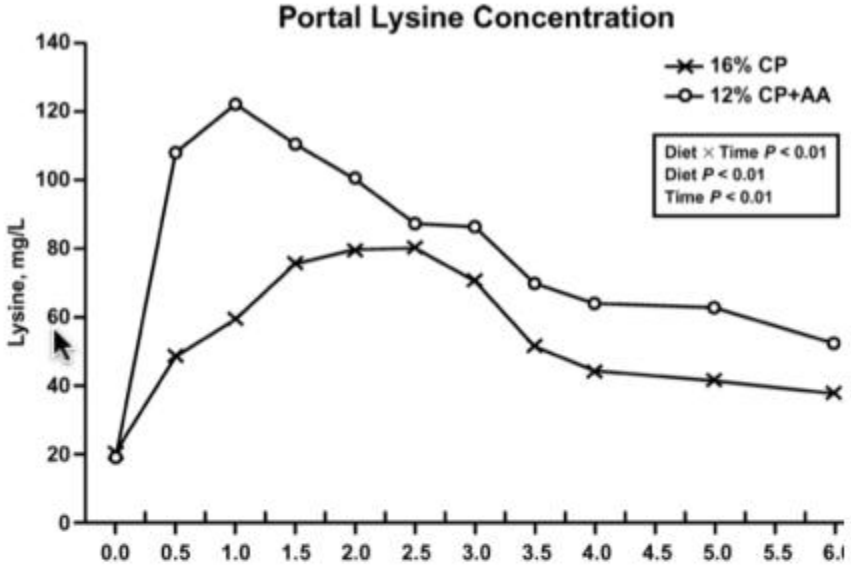
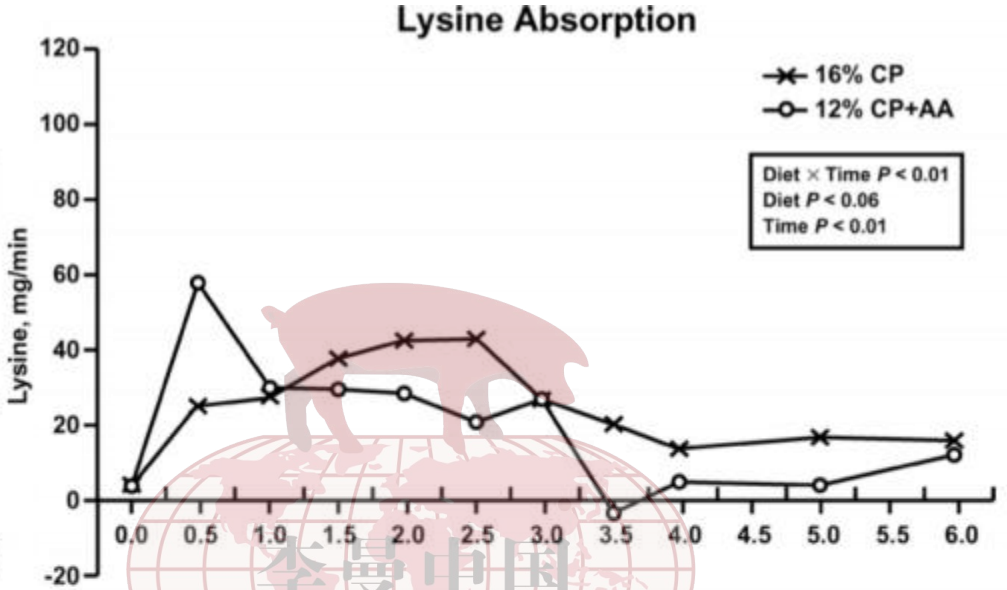
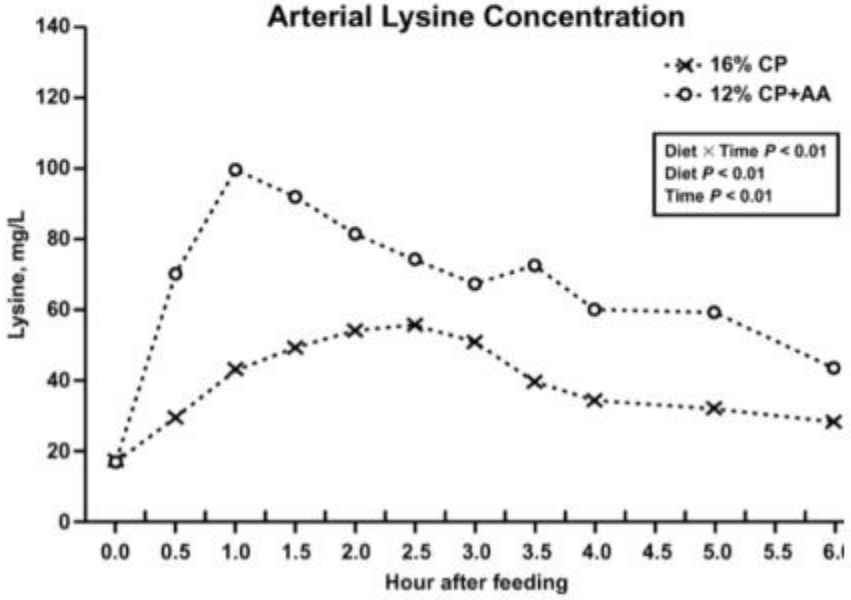
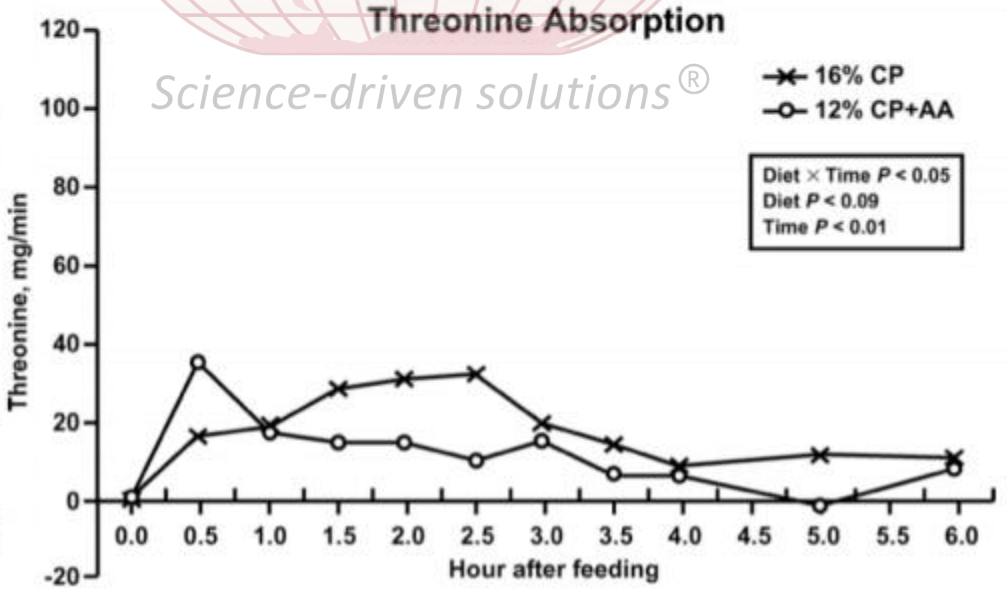








Energy： Starch？

Ca/P：？

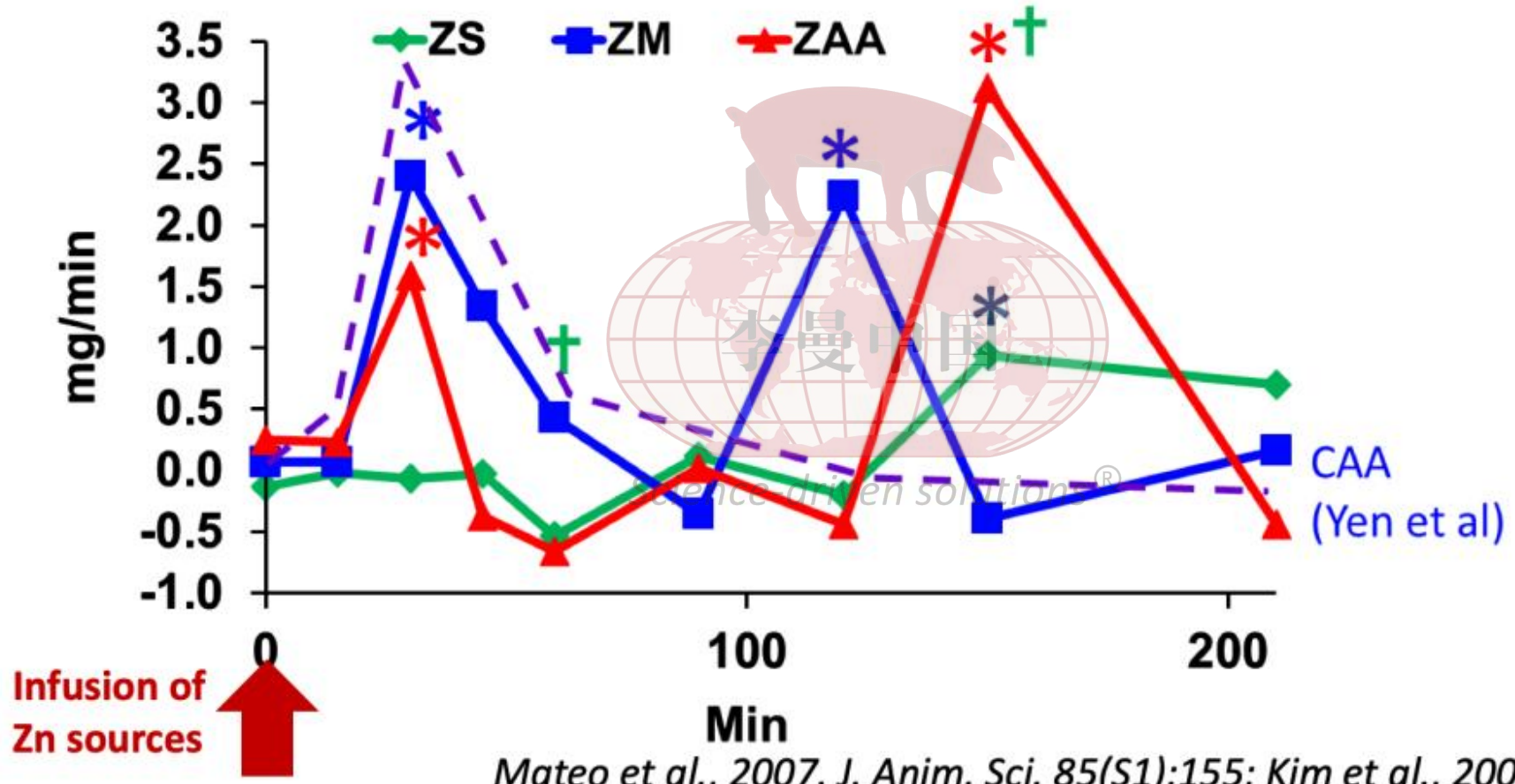
Mineral: ？

TDF：？

Yen, 2004

Differences in the Absorption of Zinc from Different Ligands

- Blood flow: 1.38 ± 0.23 L/min



Mateo et al., 2007. J. Anim. Sci. 85(S1):155; Kim et al., 2008 J. Anim. Sci. 86(S1):99

Basic Application

Standard 1

TEK-MAX

Pigs at all stages（starter pigs+G-F）+nutrition standard

ICS 65.120
B 46

团　　体　　标　　准

Group　　Standards

T/CFIAS 001—2018

仔猪、生长育肥猪配合饲料

Formula feeds for starter and growing-finishing pigs

Released on Oct. 26th,2018　　Implemented on Nov. 1st,1018

2018-10-26 发布　　2018-11-01 实施

中 国 饲 料 工 业 协 会　发布　**Published by Feed Industry Association in China**

Chart 1　Major Nutrient Composition Index　　T/CFIAS 001—2018

表1 主要营养成分指标

项目	仔猪配合饲料		生长肥育猪配合饲料			
	3 kg~<10 kg	10 kg~<25 kg	25 kg~<50 kg	50 kg~<75 kg	75 kg~<100 kg	100 kg~出栏
粗蛋白质/%	17.0~20.0	15.0~18.0	14.0~16.0	13.0~15.0	11.0~13.5	10.0~12.5
赖氨酸/% ≥	1.40	1.20	0.98	0.87	0.75	0.65
蛋氨酸*/% ≥	0.39	0.34	0.27	0.24	0.21	0.18
苏氨酸/% ≥	0.87	0.74	0.58	0.54	0.47	0.38
色氨酸/% ≥	0.24	0.20	0.17	0.15	0.13	0.11
缬氨酸/% ≥	0.90	0.77	0.63	0.56	0.48	0.42
粗纤维/% ≤	5.0	6.0	8.0	8.0	10.0	10.0
粗灰分/% ≤	7.0	7.0	8.0	8.0	9.0	9.0
钙/%	0.50~0.80	0.60~0.90	0.60~0.90	0.55~0.80	0.50~0.80	0.50~0.80
总磷/%	0.50~0.75	0.45~0.70	0.40~0.65	0.30~0.60	0.25~0.55	0.20~0.50
氯化钠/%	0.30~1.00	0.30~1.00	0.30~0.80	0.30~0.80	0.30~0.80	0.30~0.80
注：总磷含量已经考虑了植酸酶的使用。						
* 表中蛋氨酸的含量可以是蛋氨酸+蛋氨酸羟基类似物及其盐折算为蛋氨酸的含量；如使用蛋氨酸羟基类似物及其盐，应在产品标签中标注折算蛋氨酸系数。						

3.5　卫生指标　　**3.5 Hygienic Index**

应符合 GB 13078 的规定。　　Comply with the regulatins of GB13078

4　采样　　**4 sampling**

按 GB/T 14699.1 规定执行。　　In accordnce with the regulations of GB/T 14699.1

5　试验方法　　**5 experinment method**

5.1　感官检验　　**5.1 Organic Inspection**

取适量样品置于清洁、干燥的白瓷盘中，在正常光照、通风良好、无异味的环境下，通过目测、鼻嗅进行检验。

5.2　水分　　**5.2 Moisture**

Standard 2

Pigs at all stages+nutrition standards+Feedstuffs recommendations+Typical formulations

ICS 65.120
CCS B 46

团　　体　　标　　准

T/CFIAS 8001—202

Group Standards

生猪低蛋白低豆粕多元化日粮生产技术规范

Specification of practice for the diversified diets with low protein and low soybean meal for pigs

Released on Apr. 13th, 2022　　Implemented on May 13th,2022

2022-04-13 发布　　2022-05-13 实

中国饲料工业协会　　发布

Published by Feed Industry Association in China

产品混合均匀度变异系数应不大于10%。

4.7.4　营养成分指标

4.7.4.1　仔猪、生长育肥猪日粮的主要营养成分指标见表3。

Chart 3 Major Nutrition Index for the Diets of Starter and Growing-finishing Pigs
表3　仔猪、生长育肥猪日粮主要营养成分指标

项目	仔猪		生长育肥猪			
	3 kg～<10 kg	10 kg～<25 kg	25 kg～<50 kg	50 kg～<75 kg	75 kg～<100 kg	100 kg～出栏
粗蛋白质/%	17.0～20.0	15.0～18.0	14.0～16.0	13.0～15.5	11.0～14.0	10.0～13.0
赖氨酸（SID赖氨酸）/% ≥	1.40（1.26）	1.20（1.06）	0.98（0.92）	0.87（0.77）	0.75（0.66）	0.65（0.57）
蛋氨酸（SID蛋氨酸）[1]/% ≥	0.39（0.35）	0.34（0.30）	0.27（0.25）	0.24（0.20）	0.21（0.18）	0.18（0.15）
苏氨酸（SID苏氨酸）/% ≥	0.87（0.75）	0.74（0.63）	0.58（0.54）	0.54（0.47）	0.47（0.41）	0.38（0.33）
色氨酸（SID色氨酸）/% ≥	0.24（0.21）	0.20（0.18）	0.17（0.15）	0.15（0.13）	0.13（0.12）	0.11（0.09）
缬氨酸（SID缬氨酸）/% ≥	0.90（0.78）	0.77（0.67）	0.63（0.59）	0.56（0.49）	0.48（0.43）	0.42（0.37）
异亮氨酸（SID异亮氨酸）/% ≥	0.78（0.68）	0.67（0.59）	0.55（0.51）	0.49（0.43）	0.42（0.37）	0.36（0.31）
粗纤维/% ≤	5.0	6.0	8.0	8.0	10.0	10.0
粗灰分/% ≤	7.0	7.0	7.5	7.5	7.5	7.5
钙/%	0.50～0.80	0.60～0.90	0.60～0.90	0.55～0.80	0.50～0.80	0.50～0.80
总磷[1]/%	0.50～0.75	0.45～0.70	0.40～0.65	0.30～0.60	0.25～0.55	0.20～0.50
氯化钠（以水溶性氯化物计）/%	0.30～1.00	0.30～1.00	0.30～0.80	0.30～0.80	0.30～0.80	0.30～0.80

[1] 表中蛋氨酸的含量可以是蛋氨酸+蛋氨酸羟基类似物及其盐折算为蛋氨酸的含量；如使用蛋氨酸羟基类似物及其盐，应在产品标签中标注蛋氨酸折算系数。
[2] 总磷含量已经考虑了植酸酶的使用。

4.7.4.2　母猪日粮的主要营养成分指标见表4。

Chart 4 Major Nutrition Index for Diets of Sows
表4　母猪日粮主要营养成分指标

项目	妊娠母猪		泌乳母猪
	妊娠天数≤90	妊娠天数>90	
粗蛋白质/%	9.5～13.5	11.0～16.0	16.0～18.0
赖氨酸（SID赖氨酸）/% ≥	0.60（0.55）	0.84（0.77）	0.80（0.74）
蛋氨酸（SID蛋氨酸）[1]/% ≥	0.19（0.17）	0.25（0.23）	0.21（0.19）
苏氨酸（SID苏氨酸）/% ≥	0.48（0.44）	0.60（0.55）	0.50（0.46）
色氨酸（SID赖氨酸）/% ≥	0.12（0.11）	0.15（0.14）	0.15（0.14）
缬氨酸（SID缬氨酸）/% ≥	0.47（0.43）	0.62（0.57）	0.68（0.63）
异亮氨酸（SID异亮氨酸）/% ≥	0.34（0.29）	0.58（0.49）	0.55（0.47）
中性洗涤纤维/% ≥	18.0	18.0	-
中性洗涤纤维/% ≤	-	-	14.0
粗灰分/% ≤	7.5	7.5	7.5
钙/%	0.50～0.65	0.65～0.80	0.60～0.85
总磷[1]/%	0.40～0.55	0.50～0.65	0.50～0.75
氯化钠（以水溶性氯化物计）/%	0.30～0.80	0.30～0.80	0.30～0.80

[1] 表中蛋氨酸的含量可以是蛋氨酸+蛋氨酸羟基类似物及其盐折算为蛋氨酸的含量；如使用蛋氨酸羟基类似物及其盐，应在产品标签中标注蛋氨酸折算系数。
[2] 总磷含量已经考虑了植酸酶的使用。

Standard 2

TEK-MAX

Feedstuff Recommendations

17 kinds of energy feedstuff

Chart 1 Recommended maximum amounts of non-conventional feed ingredients in diets for pigs at different physiological stages

表 1　生猪不同生理阶段日粮中非常规饲料原料推荐最高用量　　单位为%

项目	仔猪		生长育肥猪		母猪	
	3 kg～<10 kg	10 kg～<25 kg	25 kg～<50 kg	50 kg～出栏	妊娠母猪	泌乳母猪
能量饲料						
糙米	40	40	60	60	60	60
大豆皮	5	5	10	10	30	10
稻谷	-	10	30	30	30	20
高粱	-	10	80	80	80	80
裸大麦	25	80	80	80	80	80
皮大麦	15	25	25	25	80	20
米糠	-	10	30	30	30	10
木薯粉	-	15	30	30	30	30
苜蓿干草粉	-	5	10	15	30	5
喷浆玉米皮	-	-	15	15	10	5
玉米皮	-	5	10	10	10	5
碎米	40	40	60	60	60	60
豌豆	10	15	20	20	30	30
小麦	45	45	80	80	80	80
小麦次粉	10	10	40	40	40	40
小麦麸	5	10	10	20	30	15
燕麦	15	40	40	40	40	30

19 kinds of protein feedstuff

蛋白质饲料						
大豆浓缩蛋白	10	10	-	-	-	-
蛋粉	10	10	-	-	-	-
干白酒糟	-	10	10	10	10	10
干啤酒糟	-	10	10	10	10	10
含可溶物的玉米干酒精糟	5	10	20	20	20	20
花生粕	-	-	10	10	10	-
葵花籽仁粕	-	5	10	15	15	10
米糠粕	-	10	30	30	30	10
棉籽粕	-	10	10	10	15	10
膨化大豆	10	10	-	-	-	5
乳粉	40	30	-	-	-	-
乳清粉	25	10	-	-	-	-
双低菜籽粕	-	10	15	15	15	15
甜菜粕	-	5	10	10	50	10
亚麻粕	-	-	5	5	5	-
鱼粉	15	15	-	-	5	5
玉米蛋白粉	-	5	5	5	5	5
玉米胚芽粕	10	20	20	20	30	15
芝麻粕	-	5	15	15	15	5

1：注意饲料原料真菌毒素对替代比例的影响。

2："-"表示不推荐使用或使用不经济。

Soybean meal use limit in diets for different physiological stages of pigs

表 2　生猪不同生理阶段日粮中豆粕使用限量　　单位为%

仔猪		生长育肥猪				母猪	
3 kg～<10 kg	10 kg～<25 kg	25 kg～<50 kg	50 kg～<75 kg	75 kg～<100 kg	100 kg～出栏	妊娠母猪	泌乳母猪
15	16	13	10	8	5	8	16

Soybean Meal Limit

Standard 2

TEK-MAX

Typical Formulations

Chart A1 Typical Formulations of Diversified low-protein and low-Soybean Diets for starter and Growing-finishing Pigs

表 A.1 仔猪、生长育肥猪低蛋白低豆粕多元化日粮典型配方

单位为%

项目	仔猪		生长育肥猪			
	3 kg～<10 kg	10 kg～<25 kg	25 kg～<50 kg	50 kg～<75 kg	75 kg～<100 kg	100 kg～出栏
玉米	26.35	38.68	50.98	46.29	45.49	38.36
膨化玉米	26.18	18.50	–	–	–	–
小麦	5.00	8.00	8.00	8.00	10.00	10.00
高粱	–	–	5.00	6.00	8.00	10.00
木薯粉	–	–	5.00	6.00	8.00	13.44
皮大麦	–	3.00	4.00	5.00	5.00	5.00
小麦麸	4.00	5.00	5.00	6.50	6.50	8.00
大豆粕	13.52	7.75	4.20	–	–	–
膨化大豆	8.00	–	–	–	–	–
乳清粉	5.00	5.00	–	–	–	–
鱼粉	3.00	2.00	–	–	–	–
花生粕	–	3.00	4.00	–	–	–
含可溶物的玉米干酒精糟	–	–	–	5.00	6.00	5.73
米糠粕	–	–	2.00	3.00	2.00	3.00
菜籽粕	–	–	2.00	3.00	3.00	3.00
玉米蛋白粉	–	2.00	2.00	2.00	–	–
棉籽粕	–	–	2.00	3.91	2.03	–
大豆油	2.00	1.50	1.00	1.00	–	–
添加剂预混合饲料	1.00	1.00	1.00	1.00	1.00	1.00
石粉	1.22	1.24	0.93	1.01	0.94	0.91
磷酸氢钙	–	–	0.98	0.43	0.27	0.03
磷酸二氢钙	0.95	0.93	–	–	–	–
葡萄糖	1.00	–	–	–	–	–
氯化钠	0.30	0.30	0.30	0.30	0.30	0.30
L-赖氨酸盐酸盐	0.90	0.92	0.75	0.77	0.66	0.56
DL-蛋氨酸	0.41	0.32	0.26	0.23	0.23	0.19
L-苏氨酸	0.36	0.31	0.24	0.22	0.22	0.18
L-色氨酸	0.07	0.08	0.06	0.07	0.07	0.06
L-缬氨酸	0.32	0.25	0.17	0.15	0.13	0.11
L-亮氨酸	0.26	0.07	0.01	–	0.05	0.04
异亮氨酸	0.16	0.15	0.12	0.12	0.11	0.09

“–”表示本配方中未使用。

Chart A2 Typical Formulations of Diversified Low-protein and Low-soybean Diets for Sows

表 A.2 母猪低蛋白低豆粕多元化日粮典型配方

单位为%

项目	妊娠母猪		哺乳母猪
	妊娠天数≤90	妊娠天数>90	
玉米	44.90	51.42	56.61
小麦	–	5.00	6.00
小麦麸	20.00	10.22	5.72
大豆粕	4.06	7.58	16.00
大豆皮	15.00	10.00	–
甜菜粕	10.89	5.00	–
含可溶物的玉米干酒精糟	–	3.00	3.00
菜籽粕	1.00	2.00	3.40
棉籽粕	1.39	2.00	3.00
大豆油	–	–	2.12
添加剂预混合饲料	1.00	1.00	1.00
石粉	0.34	0.65	0.71
磷酸氢钙	0.74	1.13	1.58
氯化钠	0.40	0.40	0.40
L-赖氨酸盐酸盐	0.18	0.33	0.26
DL-蛋氨酸	–	0.07	–
L-苏氨酸	0.10	0.15	0.08
L-色氨酸	–	0.03	0.03
L-缬氨酸	–	0.02	0.09

“–”表示本配方中未使用。

Model Selection

- Breeds, production purposes, and feeding stage divisions...
- Product Performance： ADFI, ADG, F/G…
- Product Quality： lean percentage、 quality…
- Others： cost、 immnunity、 philosophy…

Influence of Litter Size on the Performance of Lactating Sows and Piglets

TEK-MAX

parities	1	2	3	4	5	*r value*
sows number	**64**	**65**	**54**	**42**	**26**	---
ADFI, kg/d	**5.79^{a}**	**6.52^{b}**	**6.67^{b}**	**6.71^{b}**	**6.70^{b}**	< 0.01
Primary weight, kg	**224.74^{a}**	**250.98^{b}**	**274.84^{c}**	**286.43^{d}**	**294.38^{d}**	< 0.01
weight loss, kg	**-14.80**	**-16.85**	**-15.82**	**-17.10**	**-17.10**	0.94
Backfat loss, mm	**-3.22^{a}**	**-2.65^{ab}**	**-1.79^{b}**	**-2.00^{ab}**	**-1.50^{b}**	0.06
loss of eye muscle thickness, mm	**-3.25^{a}**	**-2.17^{ab}**	**-3.48^{a}**	**-1.92^{ab}**	**-0.94^{b}**	0.15
Weaning-estrus interval, 184 pigs	**5.64^{a}**	**5.22^{b}**	**5.41^{ab}**	**5.20^{b}**	**5.17^{b}**	0.06
live births	**11.30**	**11.25**	**11.26**	**11.55**	**11.85**	0.94
stillborns	**0.91**	**0.89**	**1.00**	**1.10**	**1.42**	0.50
mummy	**0.26**	**0.18**	**0.11**	**0.31**	**0.27**	0.42
Gestating piglets/sows	**11.16**	**11.22**	**11.28**	**11.33**	**10.88**	0.44
Weaning piglets/sows	**10.28^{ab}**	**10.42^{a}**	**10.32^{ab}**	**10.09^{b}**	**10.52^{a}**	0.16
Loss before weaning, %	**7.84^{ab}**	**6.59^{a}**	**7.44^{ab}**	**9.34^{b}**	**5.74^{a}**	0.20
Primary weight of piglets, kg	**1.57^{a}**	**1.77^{b}**	**1.74^{b}**	**1.60^{ac}**	**1.69^{abc}**	< 0.01
Average daily weight gain, g/d	**204.56^{a}**	**234.44^{b}**	**242.57^{b}**	**270.01^{c}**	**253.37^{bc}**	< 0.01
Final weight of piglets, kg	**5.72^{a}**	**6.29^{b}**	**6.45^{b}**	**7.00^{c}**	**6.68^{bc}**	< 0.01

Zhu zhengpeng, 2010

Sex Difference

TEK-MAX

Growth performance	Barrows	Gilts	SEM	Probability, $P <$
Pigs, no.	980	1,015		
Preweaning ADG, lb[2]	0.52	0.52	0.01	---[3]
Initial birth wt, lb	3.51	3.50	0.01	---
Weaning age, d	25.09	25.06	0.44	---
ADG, lb				
d 0 to d 22	0.73	0.76	0.03	0.0001
d 22 to 44	1.40	1.39	0.07	---
d 0 to d 44	1.06	1.08	0.02	0.06
d 44 to 74	1.63	1.50	0.04	0.0001
d 0 to d 74	1.29	1.25	0.02	0.0001
d 74 to 156	2.02	1.80	0.03	0.0001
d 0 to 156	1.68	1.54	0.02	0.0001

Item	Barrows	Gilts	SE	*P*-value
Growth performance (d 0 to 82)				
ADG, kg	1.07	1.00	0.01	0.01
ADFI, kg	2.88	2.60	0.05	0.01
G:F	0.37	0.39	0.00	0.03
Carcass characteristic				
HCW, kg	96.1	91.6	1.9	0.04
Yield, %	72.7	72.8	0.3	0.72
Last-rib backfat, mm^2	25.9	21.8	1.5	0.04
10th-rib backfat, mm^2	20.1	16.0	0.9	0.01
Loin depth, mm^2	57.9	58.2	1.9	0.01
Lean,[2] %	53.6	56.4	0.6	0.01

KSU，2012

Scientific Stage Nutrition and Feeding

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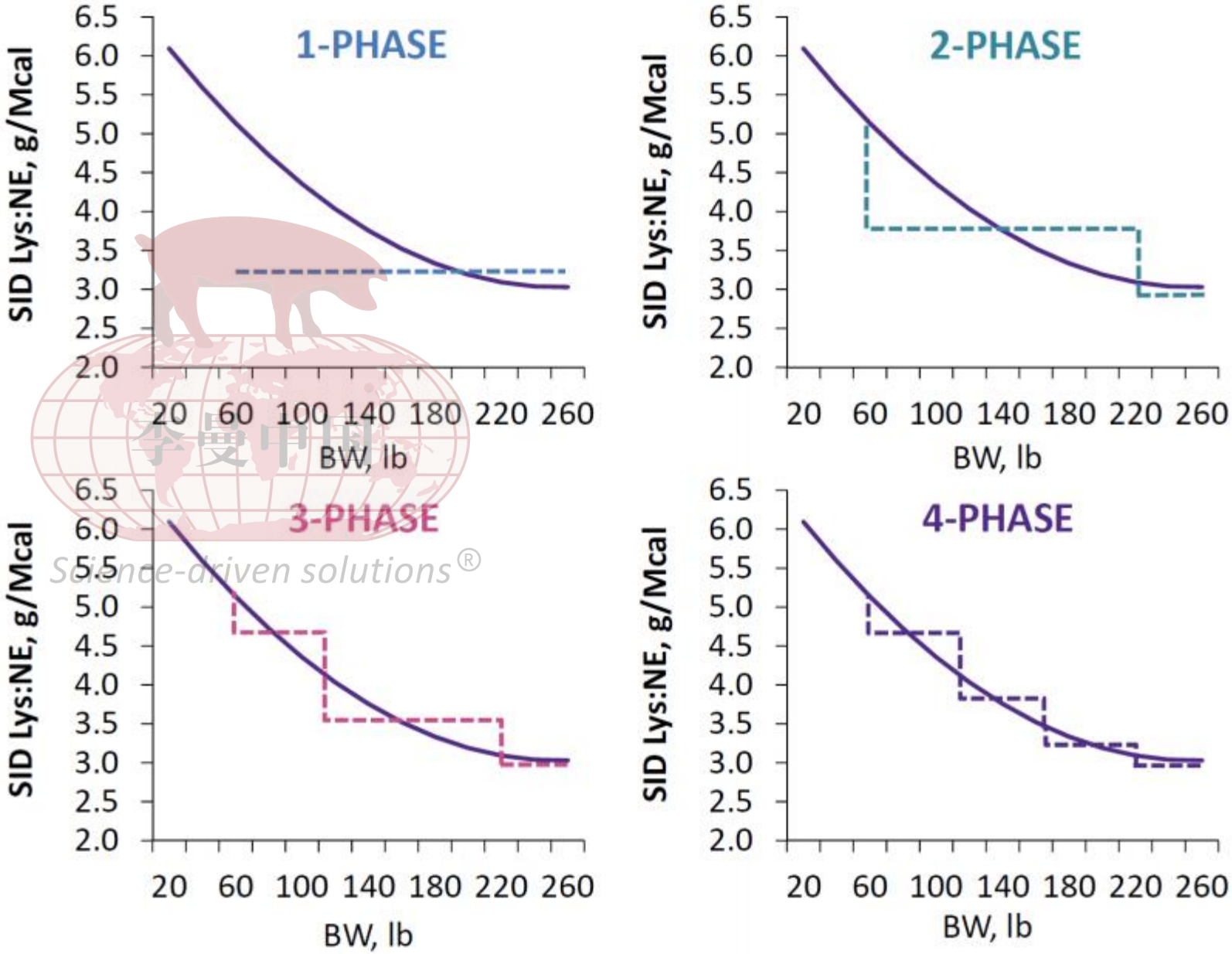
- Physiological features
- nutrition requirements
- Economic factors
- …



Results of a Low-protein Study in Sows

TEK-MAX

Study	CP, %	SID Lys, %	SID Thr, %	SID M+C, %	SID Trp, %	Litter gain, kg	Piglet ADG, g/d	Sow BW loss, g/d	Sow fat change Δ	Sow protein Δ
Manjarin et al., 2012	17.52	1.11	0.69	0.55	0.21	1.71	214	228	-	-
	13.53	0.85	0.53	0.42	0.16	2.26	282	232	-	-
Huber et al., 2015	17.62	0.74	0.59	0.50	0.18	1.86	186	414	-	-
	14.63	0.74	0.59	0.50	0.18	2.18	221	433	-	-
Huber et al., 2015	16.03	0.74	0.59	0.50	0.18	2.32	238	143	–0.1	+0.2
	15.70	0.74	0.59	0.50	0.18	2.53	256	176	–0.2	–0.8
	14.29	0.74	0.59	0.50	0.18	2.41	243	190	–0.1	–1.2
	13.22	0.74	0.59	0.50	0.18	2.60	260	285	–0.2	–2.7
Chamberlin et al., 2015a	17.16	0.78	0.53	0.48	0.18	2.53	262	270	-	-
	14.79	0.78	0.49	0.42	0.15	2.64	278	413	-	-
	12.56	0.78	0.49	0.41	0.15	2.56	258	358	-	-
Chamberlin et al., 2015b	17.16[2]	0.78	0.53	0.48	0.18	2.60	265	500	–0.06	-
	12.56[2]	0.78	0.49	0.41	0.15	2.80	279	300	–0.13	-
	17.16[3]	0.78	0.53	0.48	0.18	2.40	244	700	–0.15	-
	12.56[3]	0.78	0.49	0.41	0.15	2.30	238	800	–0.10	-
Zhang et al., 2018	18.74	0.90	0.61	0.54	0.21	2.43	251	62	–0.05[4]	+5.4[6]
	13.78	0.90	0.58	0.49	0.17	2.56	255	395	–0.17[5]	–11.2[6]

Factors affecting the effect of low-protein diets on production performance

Potential side effects

- Costs "remain high"
- **Reduced production performance**
- **Decline in slaughter quality**
- **Decline in reproductive performance**

Core influencing factors

- Selection of models/standards: Production performance, immunization, meat quality ...
- Database: NE、SID AA ...
- **Staging and Nutritional Refinement**
- Feedstuff **selection and quality**
- **Feeding program and feeding management**

Basic Operation

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Establishment of a Prediction System for Evaluating Effective Nutrients in Raw Materials

- GE-DE-ME-NE
- CP--SID AA
- Ideal CP--Ideal AA
- TP-aP

- MAFIC
- INRA
- CVB
- NRC

Graded use of feedstuff

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. Corn： origin,bulk weight,toxin…
. Soybean meal: Origin, technique, crude fiber、 ash… .

Warehouse palletizing management

- acuurate testing
- graded palletizing
- graded formulations
- batch application

peanut meal 48 acceptable

feedstuff 物料说明	tons 吨位	location 区位	sample condition 试样状态	moisture testing 水分检测	crude protein 粗蛋白质	crude ash 粗灰分	crude fiber 粗纤维
花生粕48	35866.4	B-02-3	接受	8.6	51.4	5.82	4.4
花生粕48	20056	B-02-1	接受	8.9	49.7	5.97	4.1
花生粕48	20506.7	B-02-3	接受	9.4	50.88	5.92	4.3
花生粕48	34869	B-02-3	接受且允	8.7	49.1	7.86	4.3
花生粕48	34889	B-02-1	接受	11.7	53.5	5.89	4.2
花生粕48	29942	B-02-1	接受	11.7	53.4	6.28	4.1

SBM

CP: 46%

EE: 2%

Ash: 5%

Phytic acid: 2%

Carbohydrate: 48%[1]

Hydrolysis

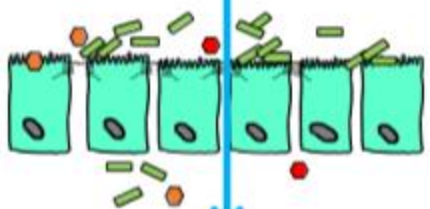
Trypsin inhibitor[5]

Activity of trypsin & chymotrypsin ↓

Protein digestibility & utilization ↓

Antigen protein[5]

i.e. Glycinin, β-conglycinin



Induce immune response

Soybean agglutinin[5]

Specifically binds to intestinal epithelial cells

Intestinal membrane immune system

Damage the structure & function of intestinal epithelial cells

Growth ↓

Feed utilization ↓

Intestinal integrity ↓

3

Viscosity ↑

Digesta transit flow ↓

Bacterial proliferation in small intestine ↑

Fecal Moisture ↑

NSP ↑

Insoluble

i.e. Raffinose[2], Stachyose[2]

Starch ↓

Soluble

NE[2,3,4] ↓

i.e. β-mannans[4]

Innate immune response ↑

[1] R. Bras. Zootec, 2013
[2] Rodney B. Hinson, 2009
[3] Swick, R.A, et.al. 2013
[4] Ausubel, F. 2005
[5] 李德发，2003

3

Staying alive

Immune losses

Cardiac losses

Cellular losses

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Correct Amino Acid Detecction Method

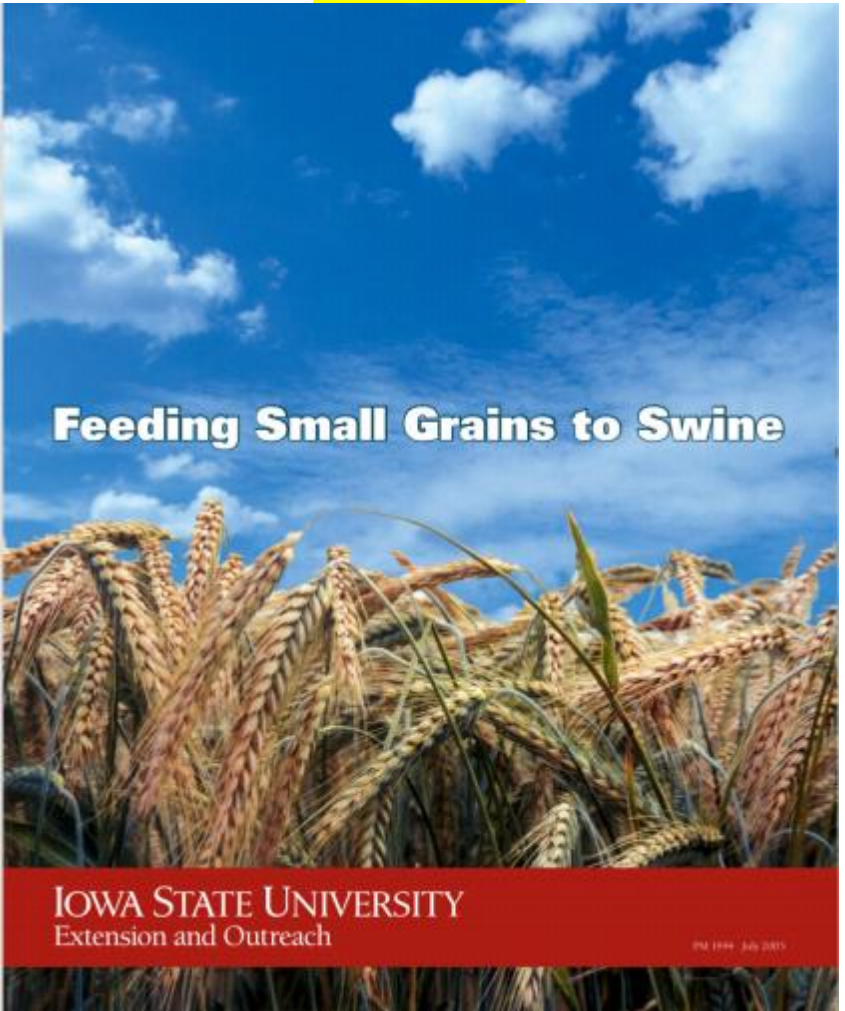
- Aicd hydrolysis: Other AA
- alkaline hydrolysis: Trp
- Oxidation hydrolysis: **SAA**

	SAA	Oxidation hydrolysis	Aicd hydrolysis	Diff.
corn	**Met**	0.17	0.14	**0.03**
	Cys	0.18	0.14	**0.04**
wheat	**Met**	0.19	0.22	**-0.03**
	Cys	0.30	0.24	**0.06**
soybean meal	**Met**	0.58	0.33	**0.25**
	Cys	0.66	0.38	**0.28**
rapeseed meal	**Met**	0.69	0.41	**0.28**
	Cys	0.91	0.43	**0.48**
cottonseed meal	**Met**	0.60	0.43	**0.17**
	Cys	0.74	0.47	**0.27**
DDGS	**Met**	0.63	0.36	**0.27**
	Cys	0.57	0.29	**0.28**
corn protein meal	**Met**	1.43	1.30	**0.13**
	Cys	1.07	0.49	**0.58**
meat meal	**Met**	0.89	0.98	**-0.09**
	Cys	0.62	0.25	**0.37**
fish meal	**Met**	1.55	1.84	**-0.29**
	Cys	0.55	0.36	**0.19**

corn: 10 samples; wheat: 10 samples; soybean meal: 10 samples; cottonseed meal: 10 samples; DDGS: 10 samples; rapeseed meal: 13 samples; meat meal: 4 samples; fish meal: 9 samples

Feedstuff quality and selection

ISU



UIUC

Alternative Feed Ingredients for Swine Rations

Introduction

Increasing feed grain and supplement costs, along with the potential for feed grain inventories to be completely depleted due to increased demand, are significant issues for producers in the pork industry. Feed costs have historically represented 65 percent-75 percent of the variable costs of swine production and are even more now for many producers. As a result, feed costs play a major role in determining the profitability of a swine enterprise.

While corn and soybean meal have been industry standards for supplying energy and protein, there are many suitable alternatives that meet nutritional requirements while reducing the cost of the ration and these may be included cost effectively as demand for corn and soybeans increases or as actual inventory shortages develop. Energy and protein are the main nutrient components in a swine ration. Grains such as corn, barley, wheat and oats have traditionally supplied energy, while protein has come from meals produced from oilseeds such as soybeans

Price relationships vary greatly depending on seasonal variability, global and local markets. Pork producers must be able to evaluate the cost effectiveness and nutritional value of various feed ingredients in order to supply a nutritionally-balanced diet at a minimal cost.

Least-cost computer ration formulation programs are available to design rations that meet minimal nutritional requirements for the least cost. Feed manufacturers and producers should use these programs effectively to purchase and maintain inventories of ingredients. Many producers do not have the storage or processing

KSU

Kansas State University applied swine nutrition

SWINE NUTRITION GUIDE
GENERAL NUTRITION PRINCIPLES

Protein Sources for Swine Diets

The main plant protein sources for swine are soybean meal, canola meal, sunflower meal, cottonseed meal, and field peas. Animal protein sources such as spray-dried blood products, meat and bone meal, and fish meal also can be used in swine diets. The most common protein sources used in swine diets are discussed in this fact sheet.

Selection of protein sources

The decision of selecting a protein source for swine diets must consider many factors, including amino acid profile and digestibility, energy content, presence of anti-nutritional factors, variability in nutrient concentration, ability to consistently source a high-

Pigs have a transitory hypersensitivity reaction to soybean meal induced by allergenic proteins, namely glycinin and β-conglycinin, and indigestible carbohydrates of soybeans. Pigs experience a period of poor nutrient absorption and low growth performance following the first exposure to a diet with high amounts of soybean meal (Li et al., 1990). The effects are transitory and pigs develop tolerance after 7 to 10 days (Engle, 1994). To alleviate the effects during this period, pigs are gradually acclimated to diets with increasing amounts of soybean meal after weaning. Furthermore, soybean meal can be further processed to remove the allergenic compounds and improve the utilization of soy proteins by weanling pigs (Jones et al., 2010).

Product Operation

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Items	Responsible Person	Decision-maker
product development	marketer	**marketer**
product function development	marketer	**marketer**
product formulations design	dietitians	**dietitians**
feedstuff selection	dietitians+purchaser	**dietitians**
quality and safety	quality controller	**quality controller**
product processing	dietitians+producer	**dietitians+producer**
product tracking improvement	marketer+quality controller+dietitians	**marketer+quality controller+dietitians**

Harmonization of product standards

Groups' Name	Location	Companies' Name	Growing Stage	Feeding Stage	total phosphorus		copper	zinc	selenium	fucoxanthin sulfate	olaquindox	guillamycin
集团名称	公司地点	公司名称	生长阶段	饲喂阶段	CP	总磷	Lys	铜	锌	硒	硫酸粘杆菌素 mg	喹乙醇	吉他霉素
Zhanjiang	湛江	piglets	乳猪	7日龄-断奶后2周	18	0.4	1.2				20	100	50
Qujing	曲靖		乳猪	7日龄-断奶后2周	18	0.4	1.2				20	100	50
Kunming	昆明		乳猪	7日龄-断奶后2周	18	0.4	1.2				20	100	50
Nanning	南宁		乳猪	3日龄-断奶后14天	18	0.4	1.35				20	100	50
Nanning	南宁		乳猪	诱食至断奶猪专用	18	0.4	1.35	200		0.5	20	100	50
Yangjiang	阳江		乳猪	7天至断奶后2周	18	0.4	1.2	200	2250	0.5	20	100	50
Xinjin	新津		乳猪	7天至断奶后2周	18	0.5	1.2	200		0.5	20	100	50
Xinjin	新津		乳猪	诱食至断奶猪专用3天至断奶后14天	18	0.5	1.35	200		0.5	20	100	50

Product Manufacturing and Operations

- product design value = Enterprise filing standards = label standard = **standards of finished product**

- nutrition **quality control** **quality control** **production**

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Staging and Cost Optimization

types 品种	教槽料1	保育料1	保育料2	保育料3	中猪料-1	中猪料-2	中猪料-3	大猪料-1	大猪料-2	大猪料-3	大猪料-4
formulation/ feed number 配方/饲料编号	YX001	YX002	YX003	YX004	YX005	YX006	YX007	YX008	YX009	YX010	YX011
Days of age 日龄，d	21-27	27-37	38-51	52-70	69-82	83-94	95-107	113-126	127-143	144-164	165-182

	YX005	YX006	YX007	YX008	YX009	YX010	YX011
	中猪料1	中猪料2	中猪料3	大猪料1	大猪料2	大猪料3	大猪料4
原料	新配方	新配方	新配方	新配方	新配方	新配方	新配方
豆粕CP43	179.50	164.00	135.50	105.00	67.50	11.50	2.00
二级玉米	496.00	496.00	481.50	437.00	412.50	407.00	415.00
二级小麦	250.00	250.00	250.00	280.00	300.00	320.00	350.00
大豆油	5.00	5.00	4.00	4.00			
发酵豆粕	25.00	20.00	15.00				
石粉	9.80	9.81	10.16	10.01	10.65	10.00	10.00
磷酸氢钙	9.70	9.69	6.84	4.99	3.35	2.00	2.50
生长育肥猪预混料2.5%	25.00	25.00	25.00	25.00	25.00	25.00	25.00
麸皮		20.50	42.00	54.00	75.00	80.00	60.50
二级小麦次粉				30.00	46.00	50.00	
米糠粕						24.50	80.00
菜籽粕			30.00	50.00	60.00	70.00	55.00
甜菜粕							
种猪预混料2.5%							
一级玉米							
总批量	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00
当前成本	**3525.52**	**3484.35**	**3422.71**	**3348.34**	**3261.27**	**3179.32**	**3152.85**
				营养成分			
粗蛋白	16.38	15.79	15.65	14.96	14.28	12.89	12.11

Reproductive Performance of Sows

TEK-MAX

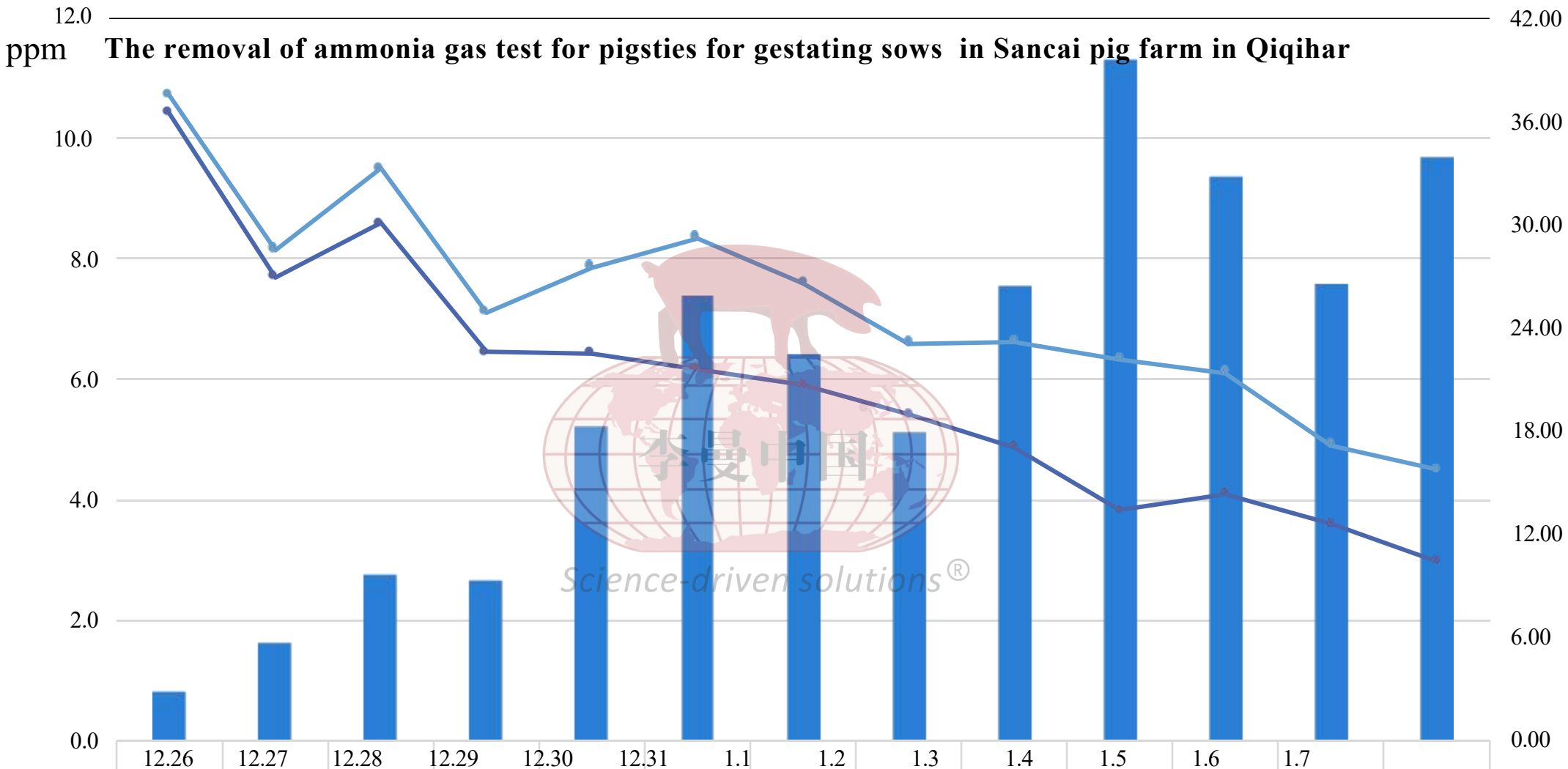
feedstuff number	month	number	weaning weight per litter, kg	average weaning weight, kg	weaning survival rate%	ammonia concentration, ppm
common#	2	20	79.3	7.45	90.6	7.2
biological#	2	20	80.6	7.60	91.4	5.3

The Reproductive Performance of Growing pigs

TEK-MAX

Assessment standards	Regular Group	Experimental Group
heads/group	90	90
days	30	30
initial weight, kg	39.56±1.73	38.59±0.86
final weight, kg	59.05±1.07	59.12±1.27
ADFI, g	1320±20 b	1360±10 a
ADG, g	650±20	680±20
F/G ratio	2.04±0.08	1.98±0.04

Sancai Swine Farms at Harawusu, Zalong, Tiefeng, Qiqihar, Heilongjiang Province



		12.26	12.27	12.28	12.29	12.30	12.31	1.1	1.2	1.3	1.4	1.5	1.6	1.7	
declined ratio	降低率	2.80	5.67	9.61	9.31	18.28	25.94	22.53	17.99	26.42	39.64	32.79	26.53	33.89	
experimental group	试验组	10.4	7.7	8.6	6.5	6.4	6.2	5.9	5.4	4.9	3.8	4.1	3.6	3.0	
control group	对照组	10.7	8.2	9.5	7.1	7.9	8.3	7.6	6.6	6.6	6.3	6.1	4.9	4.5	

Communication Generates Value

- externalVS internal
- productVS profit
- good product ≠ good production
  performance ≠ good customer
  profitability
- enhance the communication with marketer

UV x CrV x ComV = RV

UV = Understood Value means that we understand the value from the customer's point of view, including dimensions of financial, psychological and time value.

CrV = Created Value in a solution represents a superior level of performance. The value package created meets the customer's requirements or expectations and is delivered through product quality, service quality and total cost.

ComV = Communicated Value ensures that the value delivered is recognized and appreciated by key customer contacts.

RV = Recognized Value is value that is recognized by a customer. If the customer does not recognize the value, then value does not exist. Creating and keeping a customer can only be achieved by attaining recognized value in the mind of the customer.

Future Outlook

- Perception of basic research
- Refinement of basic applications
- Trade-offs in basic operations
- Environmental Considerations for Nutrition

ICS 65.120
B 46

团　　体　　标　　准

T/CFIAS 001—2018

Group　　Standards

仔猪、生长育肥猪配合饲料

Formula feeds for starter and growing-finishing pigs

Released on
Oct.26,2018

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Chart 1 Major Nutrition Indx

表1 主要营养成分指标

项目	仔猪配合饲料		生长肥育猪配合饲料			
	3 kg~<10 kg	10 kg~<25 kg	25 kg~<50 kg	50 kg~<75 kg	75 kg~<100 kg	100 kg~出栏
粗蛋白质/%	17.0~20.0	15.0~18.0	14.0~16.0	13.0~15.0	11.0~13.5	10.0~12.5
赖氨酸/% ≥	1.40	1.20	0.98	0.87	0.75	0.65
蛋氨酸/% ≥	0.39	0.34	0.27	0.24	0.21	0.18
苏氨酸/% ≥	0.87	0.74	0.58	0.54	0.47	0.38
色氨酸/% ≥	0.24	0.20	0.17	0.15	0.13	0.11
缬氨酸/% ≥	0.90	0.77	0.63	0.56	0.48	0.42
粗纤维/% ≤	5.0	6.0	8.0	8.0	10.0	10.0
粗灰分/% ≤	7.0	7.0	8.0	8.0	9.0	9.0
钙/%	0.50~0.80	0.60~0.90	0.60~0.90	0.55~0.80	0.50~0.80	0.50~0.80
总磷/%	0.50~0.75	0.45~0.70	0.40~0.65	0.30~0.60	0.25~0.55	0.20~0.50
氯化钠/%	0.30~1.00	0.30~1.00	0.30~0.80	0.30~0.80	0.30~0.80	0.30~0.80

注：总磷含量已经考虑了植酸酶的使用。

* 表中蛋氨酸的含量可以是蛋氨酸+蛋氨酸羟基类似物及其盐折算为蛋氨酸的含量；如使用蛋氨酸羟基类似物及其盐，应在产品标签中标注折算蛋氨酸系数。

3.5 卫生指标　**3.5 Hygienic Index**

应符合 GB 13078 的规定。

4 采样　**4 Sampling**

按 GB/T 14699.1 规定执行。

5 试验方法　**5 Experiment Method**

5.1 感官检验　**5.1 Organic inspection**

取适量样品置于清洁、干燥的白瓷盘中，在正常光照、通风良好、无异味的环境下，通过目测、鼻嗅进行检验。

5.2 水分　**5.2 Moisture**


Thanks !
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