Use of Reduced-Oil DDGS in Swine and Poultry Feeding Programs
低脂DDGS在猪料和禽料中的应用

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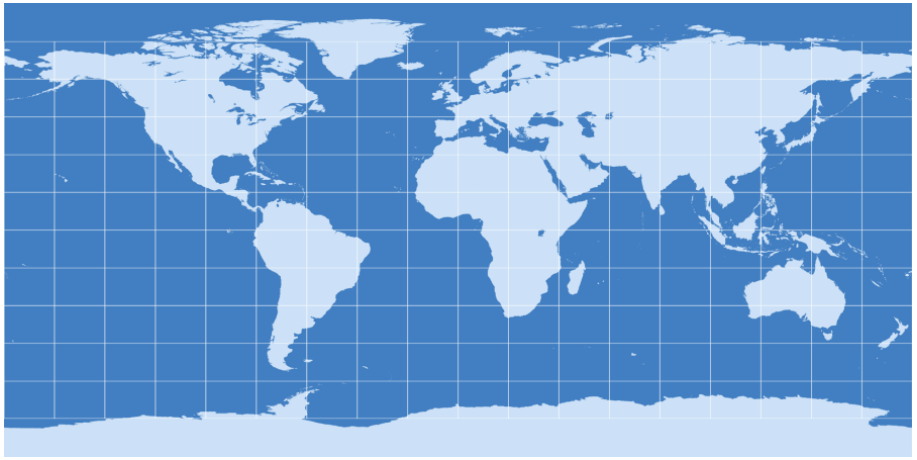


DDGS – An Evolving Feed Ingredient
DDGS — 不断进步的饲料原料

Oil extraction in the U.S. ethanol industry
美国燃料乙醇产业中的油脂提取

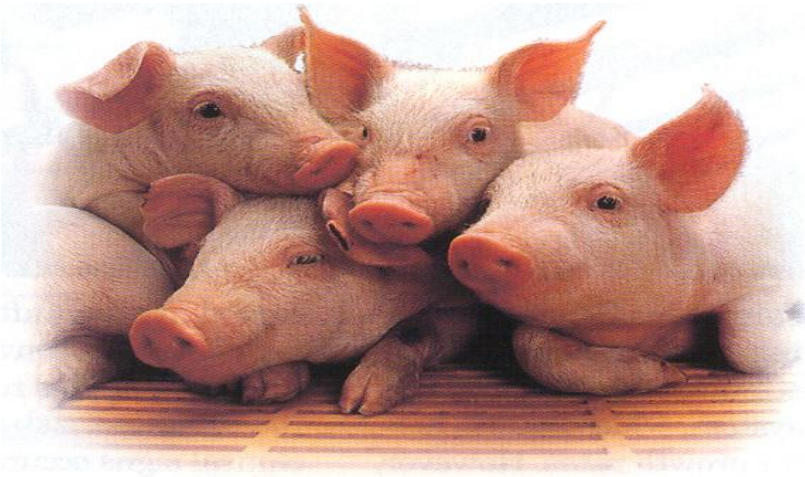
- **Industry adoption** 行业应用
  - **> 85% of ethanol plants** are extracting corn oil
    超过85%的乙醇厂提取玉米油
  - Extracted by **centrifugation of thin stillage** prior to making DDGS
    在DDGS生产环节前**离心分离酒糟水**提取
  - More than 1.13 billion kg of distillers corn oil was produced in 2014
    2014年从玉米酒糟中生产超过11.3亿公斤玉米油

- **Oil uses** 油的用途
  - 53% is being used in **biodiesel production** 53%用于**生产生物柴油**
  - 43% is being used in **swine and poultry feeds** 43%用于**猪料和禽料**
  - 4% is being used in **other industrial applications** 4%用于**其他工业用途**

- **Impact on DDGS** 对DDGS的影响
  - **Reduced metric tonnes of DDGS** 减少DDGS的产量
  - **Energy and nutrient content are more variable** 能量和营养成分变化更大
  - **May reduce energy** content and feeding value 可能降低能量值和饲喂价值
    - Crude fat content ranges from 4 to 14% 粗脂肪含量从4%到14%
    - **Most reduced-oil DDGS is 7 to 9% crude fat** 大部分低脂DDGS粗脂肪含量在7%到9%

How much DDGS can I use in various swine diets?

不同猪料中DDGS的使用量是多少？



U.S. dietary DDGS inclusion rates and estimated usage 美国日粮中DDGS的添加比例和使用量

- About 7 million MT of DDGS is fed to swine in the U.S. annually
  美国每年猪料中DDGS的使用量大约七百万吨

  - Grower-finisher diets ~85%
    生长-育肥猪日粮 ~85%
    - 10-40% of the diet 日粮中添加10-40%

  - Sow diets ~5-10% 母猪日粮~5-10%
    - Gestation – 10-50% of the diet
      妊娠期 — 日粮中添加10-50%
    - Lactation – 10-30% of the diet
      泌乳期 — 日粮中添加10-30%

  - Late nursery diets < 5%
    保育后期日粮< 5%
    - Added at 5-30% of the diet
      日粮中添加5-30%

Nutrient content and variability of low, medium, and high-oil DDGS 低中高脂DDGS中的营养成分及含量

%, As-fed Basis 饲喂量占比	Low-oil (<4%) DDGS 低脂（低于4%）DDGS	Medium-oil (> 6 and < 9%) DDGS 中脂（6%到9%之间）DDGS	Traditional (>10%) DDGS 传统（高于10%）DDGS
Dry matter 干物质	89.3 (n = 1)	89.4 (n = 13)	89.3 (n = 59)
Crude protein 粗蛋白	**27.9 (n = 2)**	**27.4 (n = 13)**	**27.3 (n = 81)**
Crude fat 粗脂肪	3.6 (n = 2)	8.9 (n = 8)	10.4 (n = 34)
Ash 灰分	4.6 (n = 1)	4.0 (n = 9)	4.1 (n = 39)
Starch 淀粉	10.0	9.6 (n = 4)	6.7 (n = 32)
NDF 中性洗涤纤维	**33.8 (n = 2)**	**30.5 (n = 11)**	**32.5 (n = 76)**
ADF 酸性洗涤纤维	16.9 (n = 1)	12.0 (n = 9)	11.8

NRC (2012)

Amino acid content and variability of low, medium, and high-oil DDGS 低中高脂DDGS中的氨基酸成分及含量

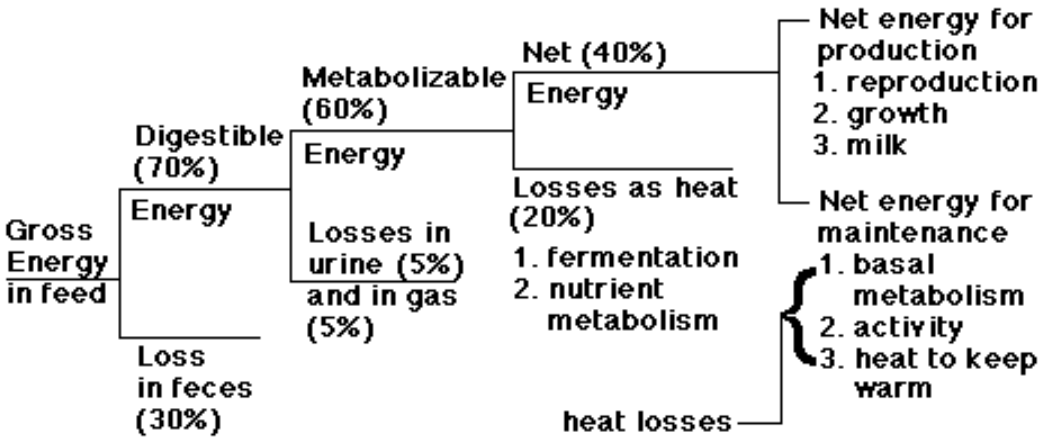
%, As-fed Basis 饲喂量占比	Low-oil (<4%) DDGS 低脂（低于4%）DDGS	Medium-oil (> 6 and < 9%) DDGS 中脂（6%到9%之间）DDGS	Traditional (>10%) DDGS 传统（高于10%）DDGS
Lysine 赖氨酸	**0.68 (n = 2)**	**0.90 (n = 9)**	**0.77 (n = 68)**
Methionine 蛋氨酸	0.50 (n = 2)	0.57 (n = 9)	0.55 (n = 68)
Cysteine 胱氨酸	0.51 (n = 2)	0.44 (n = 7)	0.51 (n = 60)
Threonine 苏氨酸	0.97 (n = 2)	0.99 (n = 9)	0.99 (n = 64)
Tryptophan 色氨酸	0.18 (n = 2)	0.20 (n = 9)	0.21 (n = 67)
Isoleucine 异亮氨酸	1.02 (n = 2)	1.06 (n = 9)	1.02 (n = 67)
Valine 缬氨酸	1.34 (n = 2)	1.39 (n = 9)	1.35 (n = 67)

NRC (2012)

GE, DE, ME, and NE content of low, medium, and high-oil DDGS 低中高脂DDGS中的能量类型及能量值

Kcal/kg, as-fed basis 千卡/公斤，以饲喂量为基础	Low-oil (<4%) DDGS 低脂（低于4%）DDGS	Medium-oil (> 6 and < 9%) DDGS 中脂（6%到9%之间）DDGS	Traditional (>10%) DDGS 传统（高于10%）DDGS
Gross energy 总能	5,098 (n = 1)	4,710 (n = 3)	4,849 (n = 41)
Digestible energy 消化能	3,291 (n = 2)	3,582 (n = 3)	3,620 (n = 16)
Metabolizable energy 代谢能	**3,102**	**3,396**	**3,434**
Net energy 净能	**2,009**	**2,343**	**2,384**

NRC (2012)

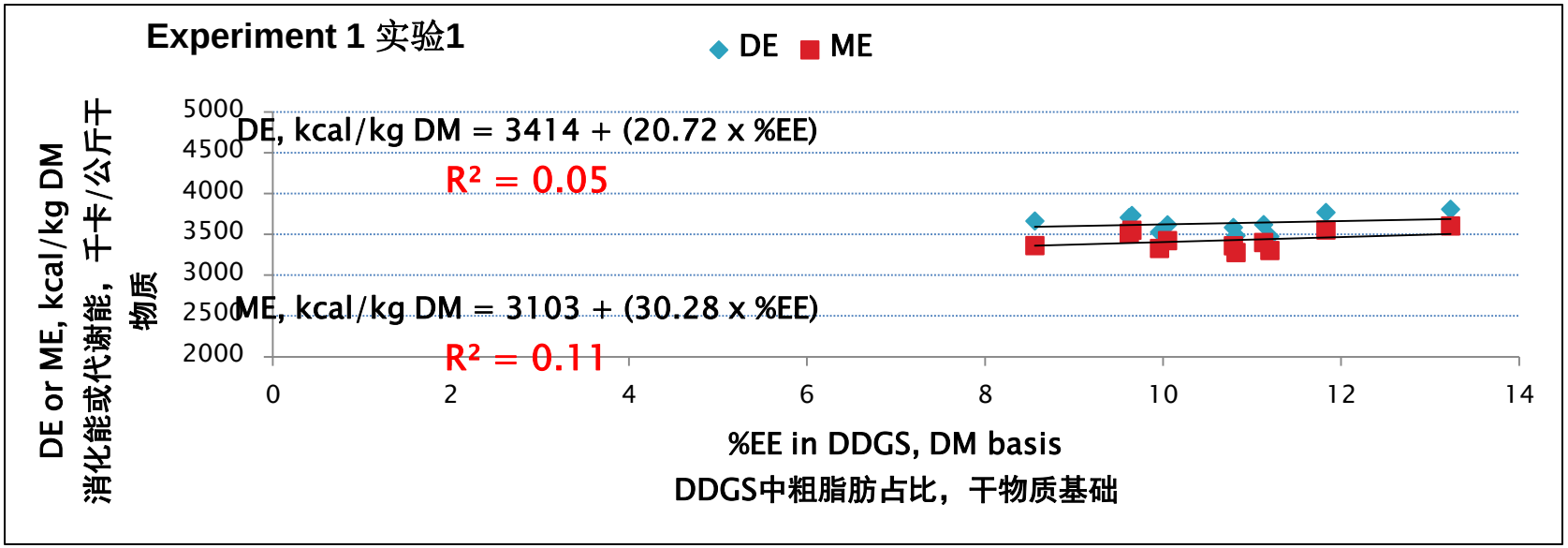


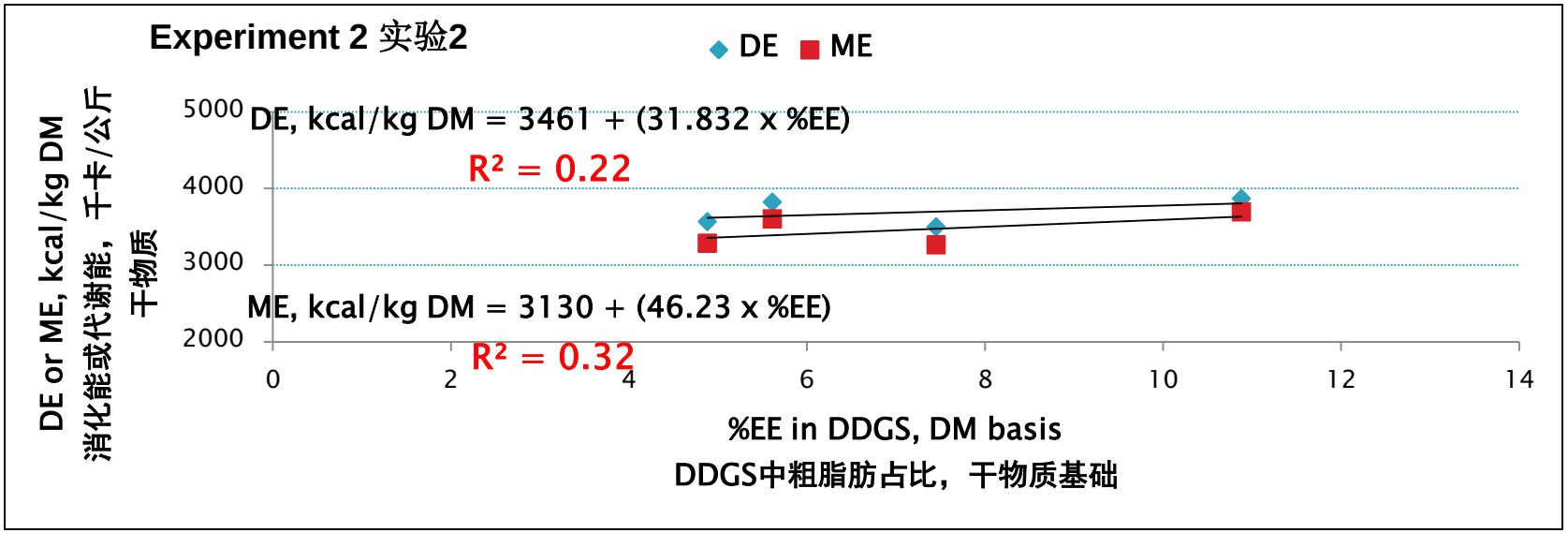
“Just tell me how much ME is reduced for each 1% reduction in oil content in DDGS!”

“我只想知道DDGS中的油脂每减少1%代谢能减少多少！”

There is a poor relationship between crude fat (EE) content of DDGS and DE and ME content

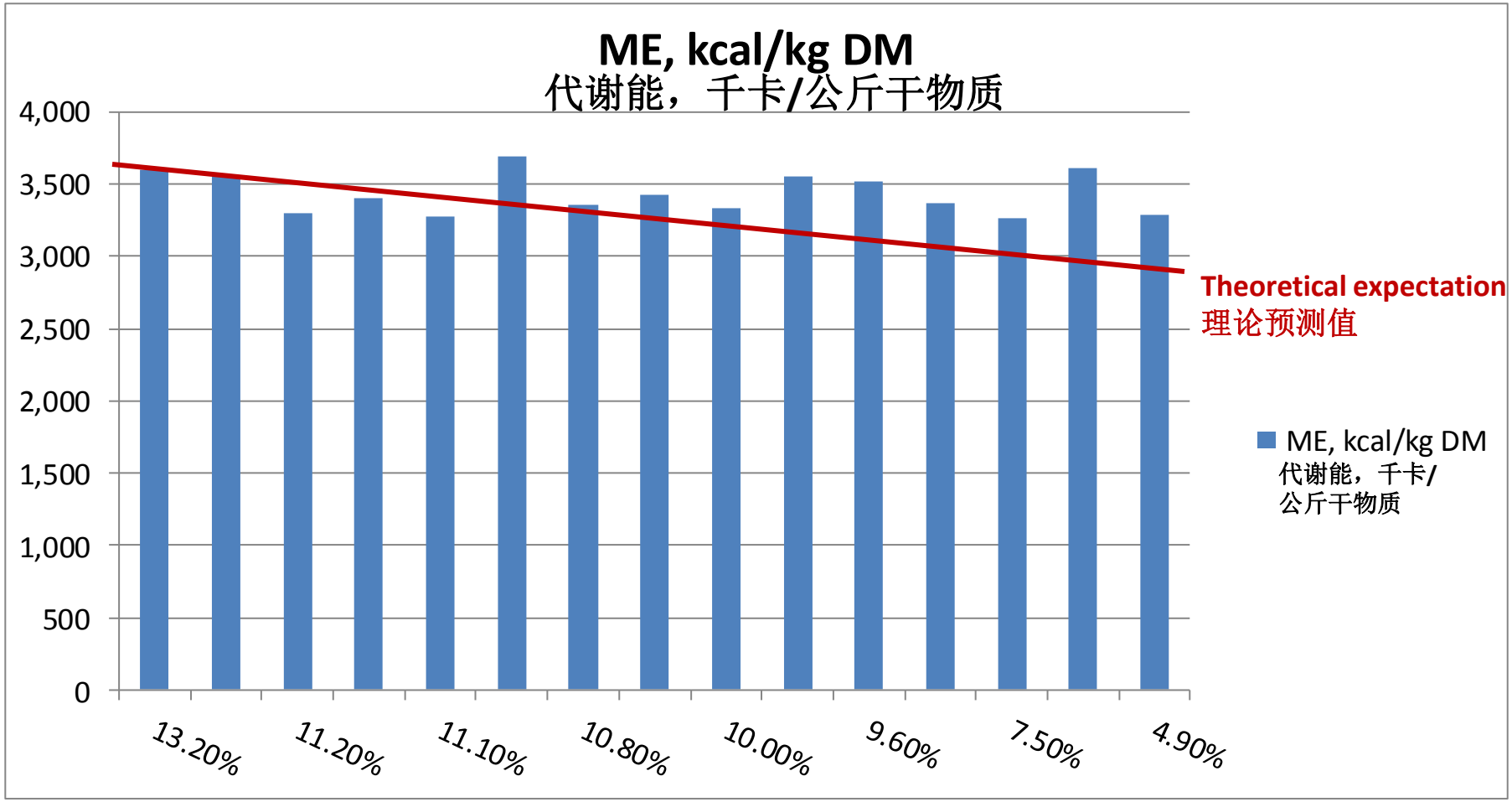
DDGS中粗脂肪含量与消化能和代谢能间的关系并不紧密





Crude fat content of DDGS is a poor predictor of ME content for swine

用DDGS中的粗脂肪含量无法准确估算猪料中的代谢能



Kerr et al. (2013)

Crude Fat Concentration

粗脂肪含量

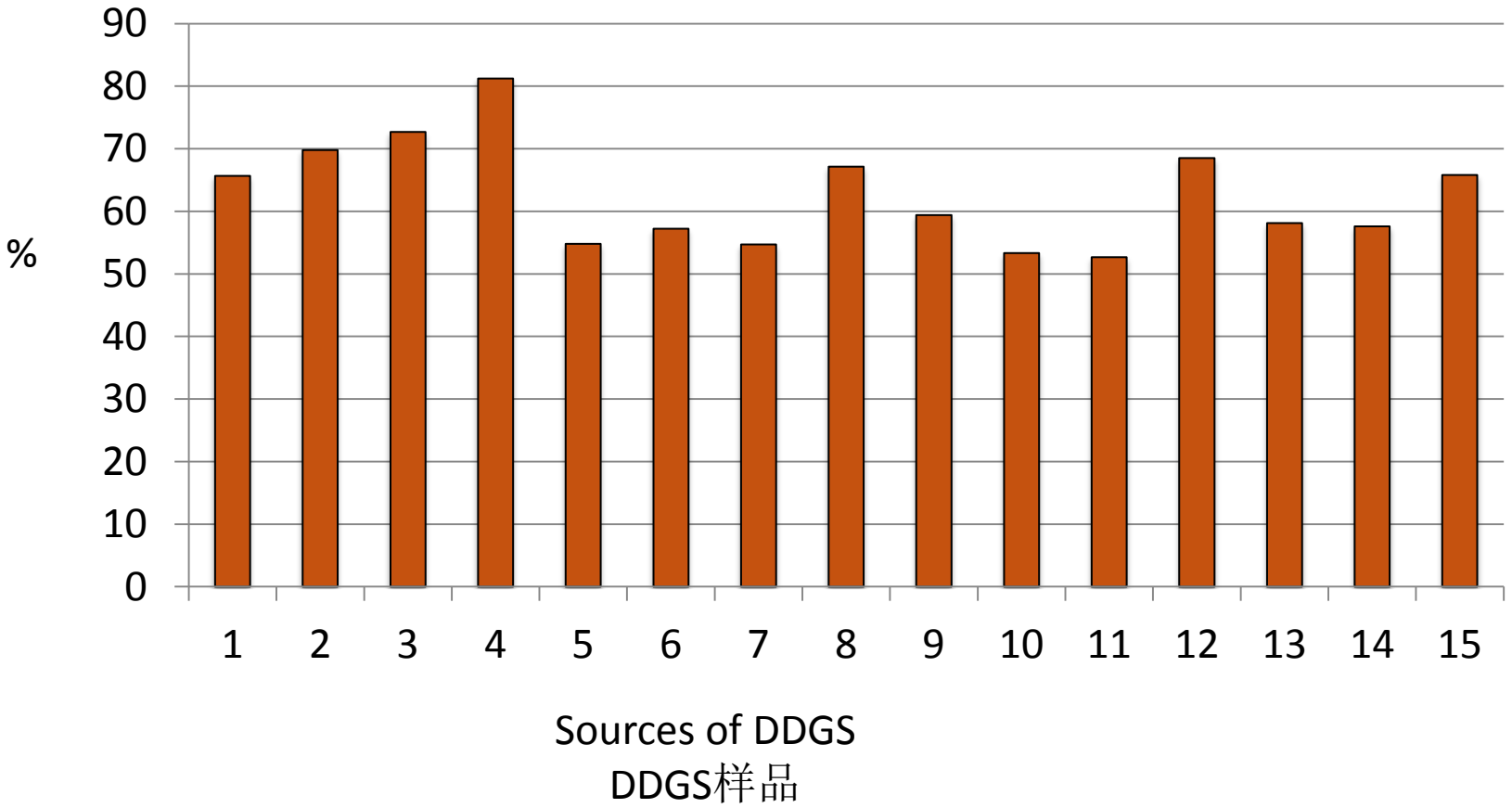
ME ranking of DDGS sources and nutrient content (DM basis)
不同DDGS的代谢能和营养成分含量（干物质基础）

DDGS Source DDGS种类	ME, kcal/kg 代谢能	Crude fat, % 粗脂肪	NDF, % 中性洗涤纤维	Crude protein, % 粗蛋白	Starch, % 淀粉	Ash, % 灰分
15	**3,696**	10.9	31.6	29.0	3.3	5.4
13	3,604	**5.6**	31.6	30.6	3.3	**6.1**
8	3,603	**13.2**	34.0	30.6	1.3	5.3
11	3,553	11.8	38.9	32.1	1.1	4.9
9	3,550	9.7	**28.8**	29.8	2.8	5.0
6	3,513	9.6	33.0	30.1	3.4	4.9
7	3,423	10.1	38.2	30.3	2.2	5.0
2	3,400	11.1	36.5	29.7	**3.9**	**4.3**
4	3,362	8.6	35.7	**32.9**	**0.8**	5.1
3	3,360	10.8	38.6	29.7	1.6	4.6
10	3,327	10.0	35.9	32.7	1.0	5.3
1	3,302	11.2	**44.0**	**27.7**	1.8	4.4
12	3,286	**4.9**	30.5	31.2	3.3	5.8
5	3,277	11.1	39.7	31.6	0.9	5.0
14	**3,266**	7.5	33.9	30.8	2.5	5.7

Kerr et al. (2013)

Green = highest value 绿色=最高值
Red = lowest value 红色=最低值

Apparent Total Tract Digestibility of Oil in DDGS
DDGS中油脂的表观全肠道消化率



Kerr et al. (2013)

Concentration of Carbohydrates and ATTD of Dietary Fiber (Swine) in Corn DDGS[1] 玉米DDGS中（猪）日粮纤维的碳水化合物浓度和表观全肠道消化率

	Average 均值	Low Value 最低值	High Value 最高值	SD
Starch, total, % 总淀粉	7.3	3.8	11.4	1.4
Starch, soluble, % 可溶性淀粉	2.6	0.5	5.0	1.2
Starch, insoluble, % 不溶性淀粉	4.7	2.0	7.6	1.5
ADF, % 酸性洗涤纤维	9.9	7.2	17.3	1.2
NDF, % 中性洗涤纤维	25.3	20.1	32.9	4.8
Insoluble TDF, % 不溶性总日粮纤维	35.3	26.4	38.8	4.0
Soluble TDF, % 可溶性总日粮纤维	6.0	2.36	8.54	2.1
TDF, % 总日粮纤维	42.1	31.2	46.3	4.9
ATTD[2] of TDF, %	**43.7**	**23.4**	**55.0**	**10.2**

[1]N = 46 for data on starch, ADF, and NDF; n = 8 for data on insoluble, soluble, and total dietary fiber.
[2]ATTD = apparent total tract digestibility

Stein and Shurson (2009)

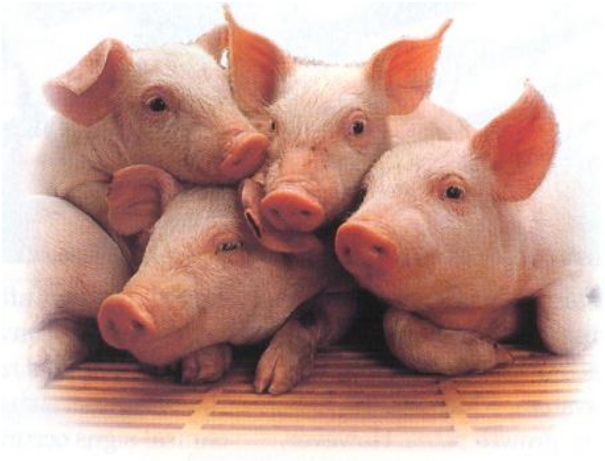
What can we do to estimate ME content of reduced-oil DDGS for swine?
我们该怎样估算低脂DDGS猪日粮中的代谢能？

Best DE and ME prediction equations for reduced-oil DDGS in swine diets (Anderson et al., 2012)
低脂DDGS猪日粮中可消化能和代谢能的最好计算公式

DE, kcal/kg DM = - 2,161 + (1.39 × GE, kcal/kg) – (20.7 × % NDF) – (49.3 × % EE)
可消化能 ,千卡/公斤干物质= - 2,161 + (1.39 ×总能kcal/kg) - (20.7 × %中性洗涤纤维) – (49.3 × %粗脂肪)
Prediction error = 144 kcal/kg　　Bias = 19 kcal/kg
预测误差= 144 千卡/公斤　　偏差值= 19千卡/公斤

ME, kcal/kg DM = – 261 + (1.05 × DE, kcal/kg) – (7.89 × % CP) + (2.47 × NDF) – (4.99 × % EE)
代谢能 ,千卡/公斤干物质= – 261 + (1.05 × 可消化能 千卡/公斤) – (7.89 × % 粗蛋白) + (2.47 × 中性洗涤纤维) – (4.99 × % 粗脂肪)
Prediction error = 149 kcal/kg　　Bias = - 82 kcal/kg
预测误差= 149 千卡/公斤　　偏差值= 82kcal/kg

GE = gross energy 总能
NDF = neutral detergent fiber 中性洗涤纤维
EE = ether extract (crude fat) 粗脂肪
CP = crude protein 粗蛋白



Urriola et al. (2014)

Validation of the accuracy of DDGS ME prediction equations
DDGS代谢能计算公式准确性验证

- We conducted a growth performance trial with growing finishing pigs to:
  我们进行了一次生长-育肥猪的生长性能实验：

  1. Determine the accuracy of ME prediction for DDGS sources containing 6, 10, and 14% crude fat, but similar ME content.
     分别用含6, 10, 和14%粗脂肪、相同代谢能量值的DDGS样品来验证代谢能估算的准确性

  2. Demonstrate that DDGS oil content does not affect growth performance and carcass composition if similar in ME content.
     实验证明代谢能量值相同的情况下DDGS油脂含量并不影响生长性能和胴体成分

Experimental design 实验设计

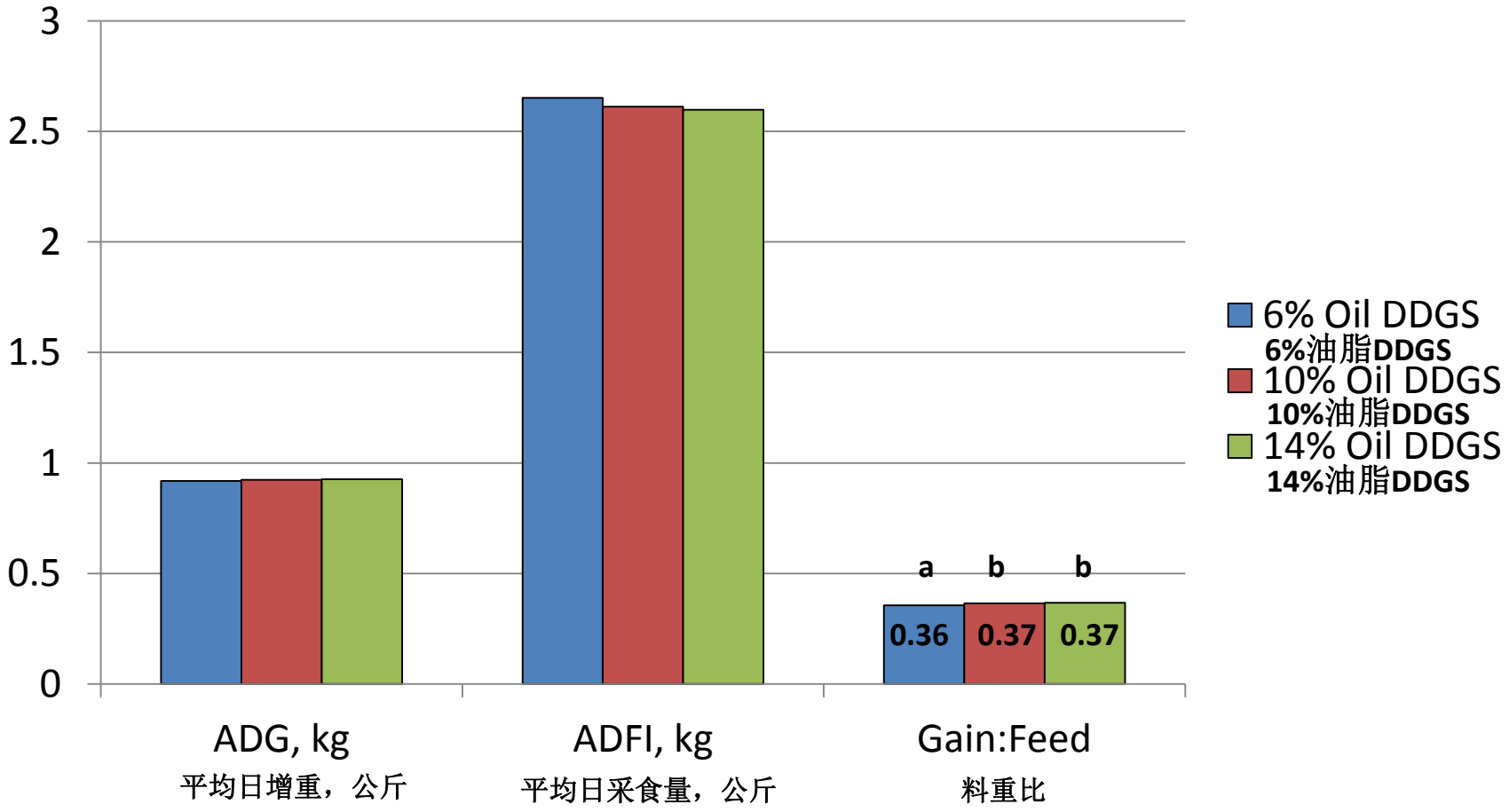
- 4-phase feeding program (changed by BW at 50, 75, and 100 kg for phase 2, 3, and 4, respectively) 四阶段饲喂实验（分别以体重50、75和100公斤为界，转到第二三四阶段）
- An example of phase 2 diet composition (as-fed basis)
  第二阶段日粮原料组成示例（以饲喂量为基础）

	CON 传统	LOW 低	MED 中	HIGH 高
Corn, % 玉米	72.3	50.9	51.0	50.9
Soybean meal, % 豆粕	25.3	6.5	6.5	6.5
DDGS, %	0.0	40.0	40.0	40.0
Minerals, vitamins, AA, % 矿物质，维生素，氨基酸	2.4	2.6	2.5	2.6
Ether extract of DDGS,% DDGS粗脂肪	-	5.9	9.9	14.2
Predicted ME of DDGS, kcal/kg DDGS代谢能预测值，千卡/公斤	-	2,998 × 40% =1,199	3,067 × 40% = 1,227	2,999 × 40% = 1,199
Dietary ME, kcal/kg 饲粮代谢能	3,325	3,186	3,212	3,186

- Diets were balanced for similar SID amino acid and STTD P content
  日粮已平衡好标准回肠消化率（SID）氨基酸和标准全肠道消化率（STTD）磷含量

Growth performance of growing–finishing pigs fed DDGS sources with different oil content but similar predicted ME content

生长-育肥猪饲喂不同油脂含量但代谢能预测值相同的DDGS，生长性能比较

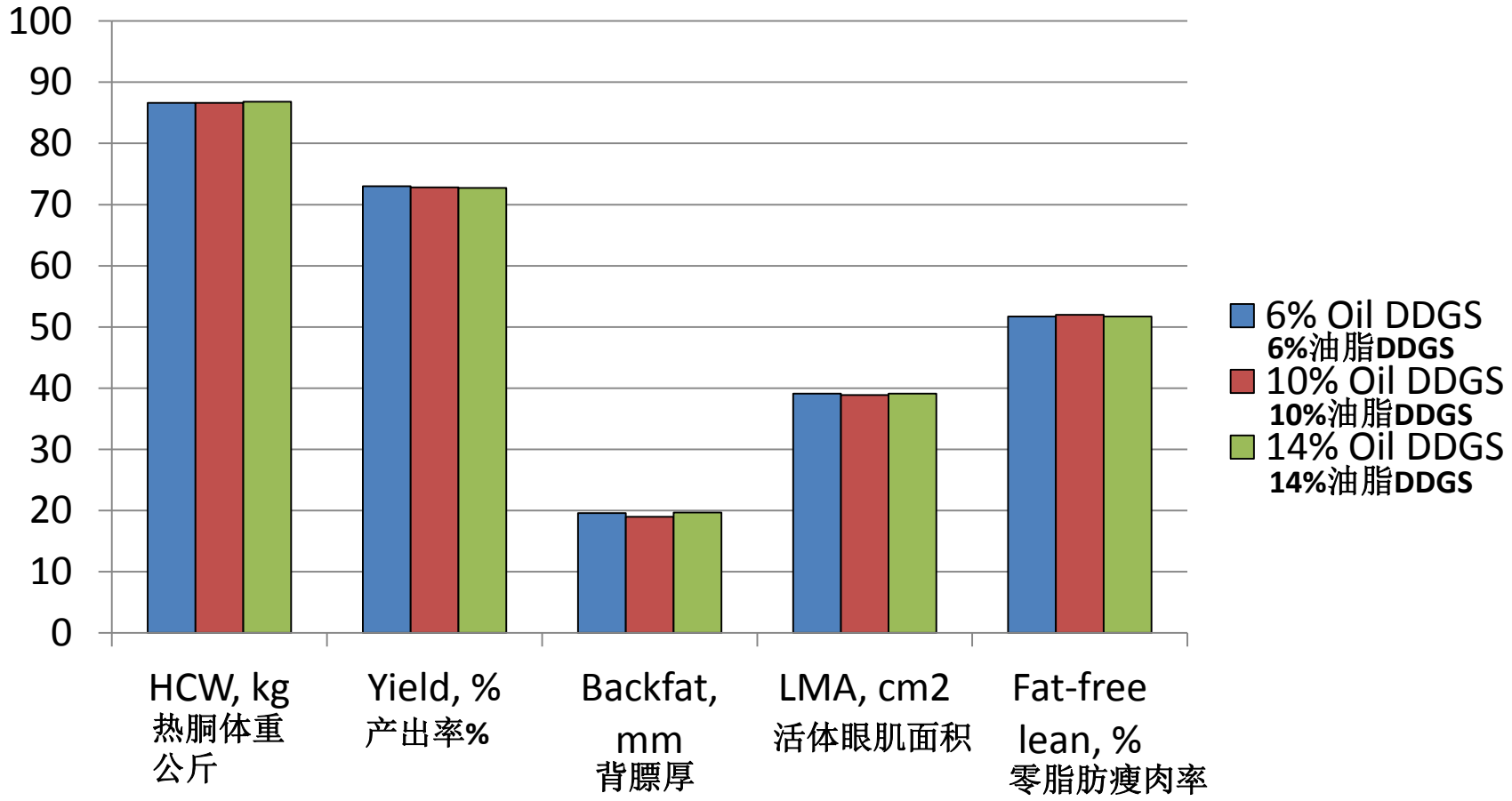


[a, b] Means with different superscripts differ ($P < 0.05$)

Wu et al. (2015)

Carcass characteristics of growing–finishing pigs fed DDGS sources with different oil content but similar predicted ME content

生长-育肥猪饲喂不同油脂含量但代谢能预测值相同的DDGS，胴体特性比较



No significant differences among DDGS sources 饲喂不同DDGS没有显著差异

Wu et al. (2015)

Conclusions 结论

DDGS	Predicted DDGS ME kcal/kg DDGS代谢能预测值 千卡/公斤		ADFI kg/d 平均日采食量 公斤/天	ADG kg/d 平均日增重	G:F 料重比	Carcass Traits 胴体性状
HIGH (14.2%) 高脂	1,199	→	2.60	0.93	0.37	No difference 无差异
MED (9.9%) 中脂	1,227		2.61	0.92	0.37	
LOW (5.9%) 低脂	1,199		2.65	0.92	**0.36**	

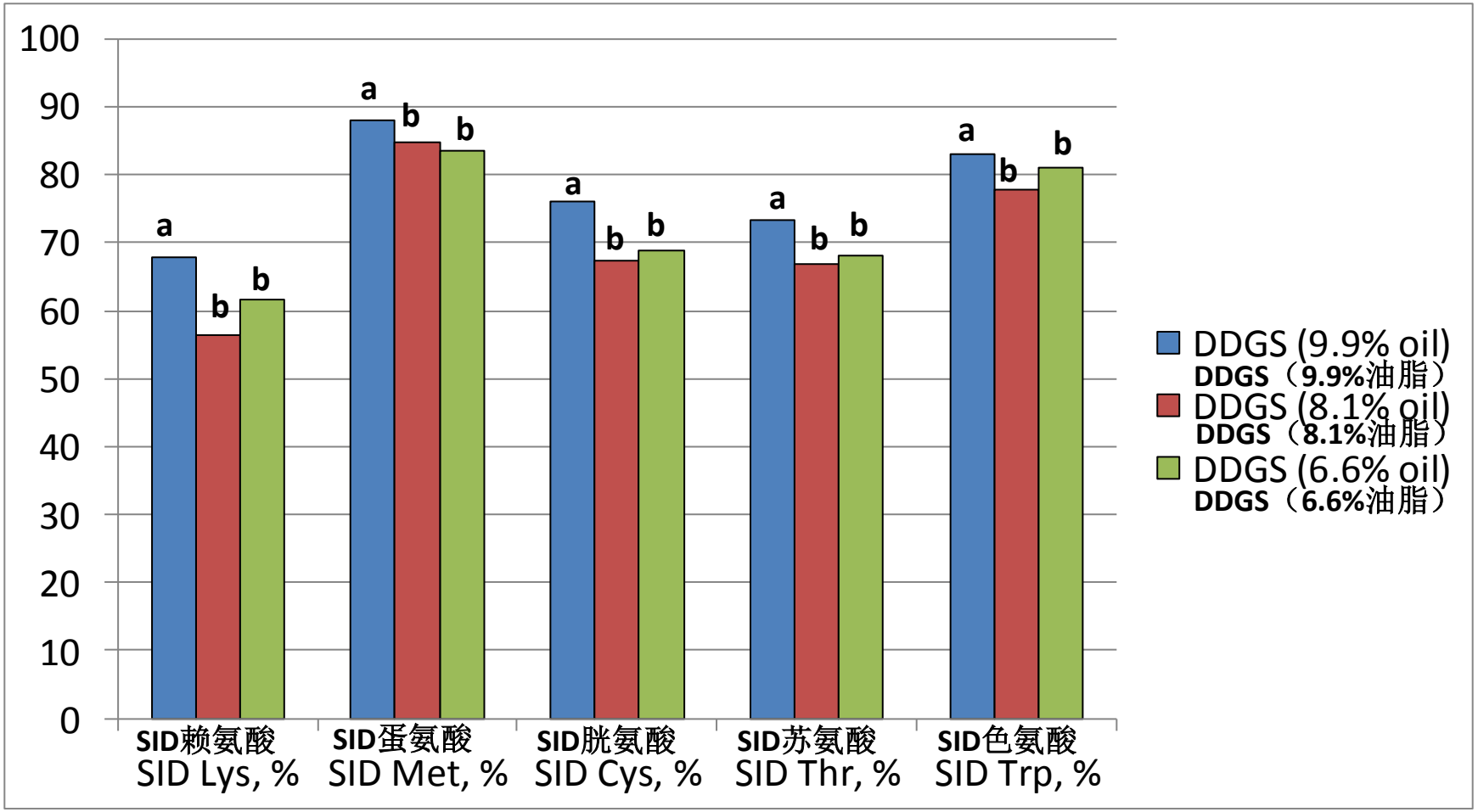
- The “best” ME equation adequately predicts ME for high and medium-oil DDGS sources, but appears to slightly overestimate ME in low-oil DDGS.
  “最好的”代谢能计算公式能够准确估算高、中脂DDGS的代谢能，但是估算低脂DDGS的代谢能时数值偏高。
- Reduced-oil content of DDGS **does not** affect growth performance and carcass composition if ME content is similar.
  在代谢能相同的条件下，DDGS中油脂含量的减少并不影响生长性能和胴体组成。

How does oil extraction affect amino acid digestibility of reduced-oil DDGS for swine?

油脂提取会不会影响低脂DDGS猪日粮的氨基酸消化率？

Amino acid digestibility of low, medium, and high-oil DDGS in growing pigs

生长猪饲喂低中高脂DDGS的氨基酸消化率



[a, b] Means with different superscripts differ ($P < 0.05$)

Curry et al. (2013)

Standardized ileal digestible amino acid prediction equations for DDGS in swine diets
DDGS在猪日粮中的标准回肠消化率氨基酸计算公式

- SID Lys = - 0.46 + (1.214 × % Lys) $r^2 = 0.79$
  SID赖氨酸 = - 0.46 + (1.214 × % 赖氨酸) $r^2 = 0.79$
- SID Lys = 0.60 – (0.463 × % ADIN) $r^2 = 0.84$
  SID赖氨酸 = 0.60 – (0.463 × % 酸性洗涤不溶氮) $r^2 = 0.84$

- SID Met = - 0.39 + (1.53 × % Met) $r^2 = 0.56$
  SID蛋氨酸 = - 0.39 + (1.53 × % 蛋氨酸) $r^2 = 0.56$
- SID Met = 0.46 – (0.161 × % ADIN) $r^2 = 0.76$
  SID蛋氨酸 = 0.46 – (0.161 × % 酸性洗涤不溶氮) $r^2 = 0.76$

- SID Thr = - 1.31 + (1.967 x % Thr) $r^2 = 0.36$
  SID苏氨酸 = - 1.31 + (1.967 x % 苏氨酸) $r^2 = 0.36$
- SID Thr = 0.75 – (0.247 × % ADIN) $r^2 = 0.54$
  SID苏氨酸 = 0.75 – (0.247 × % 酸性洗涤不溶氮) $r^2 = 0.54$

- SID Trp = - 0.24 + (1.767 x % Trp) $r^2 = 0.70$
  SID色氨酸 = - 0.24 + (1.767 x % 色氨酸) $r^2 = 0.70$

Almeida et al. (2013) - J. Anim. Sci. Biotech. 4:44

Question - Which of these DDGS sources has the highest economic value in swine diets?

问题 – 以下哪个DDGS样品在猪日粮中的经济价值最高？

	A	B	C	D	E
Dry matter, %	89.2	89.0	88.9	92.8	88.7
Crude protein, %	29.6	25.7	26.6	27.5	25.7
Crude fat, %	7.5	5.7	5.8	8.0	8.7
Starch, %	7.2	7.9	10.7	5.3	5.6
Crude fiber, %	6.9	6.7	6.7	7.2	7.1
TDN, %	69.5	66.5	66.9	75.8	70.3
Ash, %	4.5	5.2	4.3	4.9	4.8
Phosphorus, %	0.80	0.92	0.87	0.93	0.87
Lysine, %	0.92	0.90	0.90	0.89	0.82

Source: Dr. Rob Musser, Nutriquest Illuminate®

Nutritional and economic value comparison of DDGS sources in swine grower-finisher diets

生长-育肥猪日粮中不同DDGS样品的营养和经济价值对比

	A	B	C	D	E
ME, kcal/kg	3,237	3,073	3,180	3,182	3,001
NE, kcal/kg	2,302	2,190	2,278	2,256	2,141
SID Lys, %	0.58	0.65	0.63	0.60	0.45
SID Met, %	0.48	0.49	0.58	0.46	0.42
SID Thr, %	0.79	0.80	0.86	0.76	0.62
SID Trp, %	0.16	0.16	0.17	0.16	0.14
Avail. Phos, %	0.60	0.69	0.65	0.70	0.66
Relative Value ($/short ton)	**$241**	**$229**	**$253**	**$218**	**$199**

Source: Dr. Rob Musser, Nutriquest Illuminate®

DDGS spot price = $165/short ton

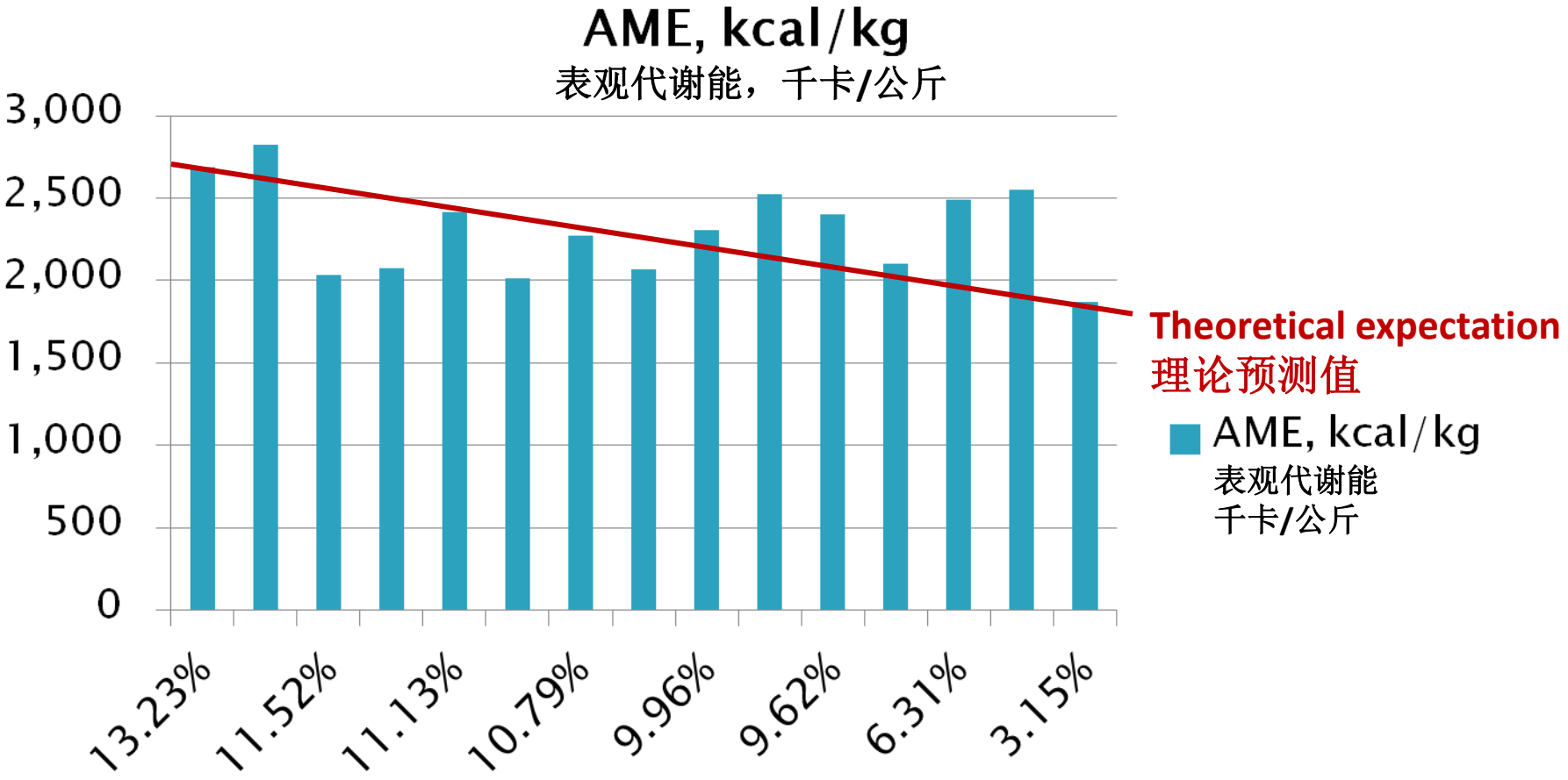
Corn price = $125/short ton **Soybean meal price = $311/short ton**

Impact of Reduced-Oil DDGS on AME_n Content and Performance for Poultry

低脂DDGS对表观氮校正代谢能和禽性能的影响

Crude fat content in reduced-oil DDGS is a poor predictor of AME_N content for poultry

用粗脂肪含量无法准确估算低脂DDGS中的表观氮校正代谢能



Source: Meloche et al. (2013)

AME_N ranking and nutrient composition of 15 DDGS sources (DM basis)
15个DDGS样品的表观氮校正代谢能和营养成分含量（干物质基础）

Green = highest value 最高值
Red = lowest value 最低值

DDGS Source 样品	AME_N kcal/kg 表观氮校正代谢能	AME_N /GE % AME_N占总能比例	Crude fat % 粗脂肪	NDF % 中性洗涤纤维	Crude protein % 粗蛋白	Starch % 淀粉	Ash % 灰分
14	2,824	55.0	11.8	38.9	32.1	1.1	4.9
15	2,687	52.0	13.2	34.0	30.6	1.3	5.3
2	2,551	51.1	4.2	27.3	27.9	3.7	4.8
6	2,526	50.9	9.7	28.8	29.8	2.8	5.0
3	2,487	49.5	6.3	27.0	28.9	3.3	5.2
11	2,418	47.6	11.1	36.5	29.7	3.9	4.3
5	2,401	48.4	9.6	33.3	30.1	3.4	4.9
7	2,309	46.7	10.0	35.9	32.3	1.0	5.3
9	2,273	44.9	10.8	38.6	29.7	1.6	4.6
4	2,103	42.9	8.6	35.7	32.9	0.8	5.1
12	2,074	40.9	11.3	44.0	27.7	1.8	4.4
8	2,068	41.9	10.1	38.2	30.3	2.2	5.0
13	2,032	40.6	11.5	27.7	26.5	3.3	4.5
10	2,012	39.9	10.8	38.9	31.0	0.9	4.9
1	1,869	39.9	3.2	51.0	34.7	3.0	5.2

Best AME_N prediction equation for reduced-oil DDGS in poultry diets
最好的低脂DDGS家禽日粮中的表观氮校正代谢能量计算公式

AME_N kcal/kg = 3,673 - (121.35 x CF) + (51.29 x EE) - (121.08 x Ash)

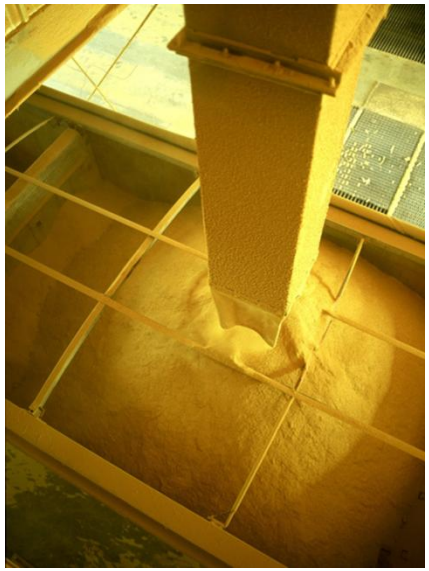
表观氮校正代谢能 千卡/公斤= 3,673 - (121.35 x 粗纤维) + (51.29 x 粗脂肪) - (121.08 x 灰分)

$R^2 = 0.70$

CF = crude fiber 粗纤维

EE = ether extract 粗脂肪

Meloche et al. (2014)



Effect of reduced-oil DDGS on layer performance

低脂DDGS对蛋鸡性能的影响

Reduced-oil DDGS nutrient profiles
低脂DDGS的营养成分表

Nutrient 营养成分	Normal DDGS 传统DDGS	Medium-Oil DDGS 中脂DDGS	Low-Oil DDGS 低脂DDGS
Crude protein, % 粗蛋白	28.9	28.3	27.5
Crude fat, % 粗脂肪	**11.2**	**7.3**	**5.6**
Crude fiber, % 粗纤维	7.4	6.9	6.8
Lysine, % 赖氨酸	1.00	0.86	0.83
Methionine, % 蛋氨酸	0.55	0.58	0.55
Cysteine, % 胱氨酸	0.74	0.70	0.57
TSAA, % 总含硫氨基酸	1.19	1.28	1.12
Phosphorus, % 磷	0.98	0.84	0.91

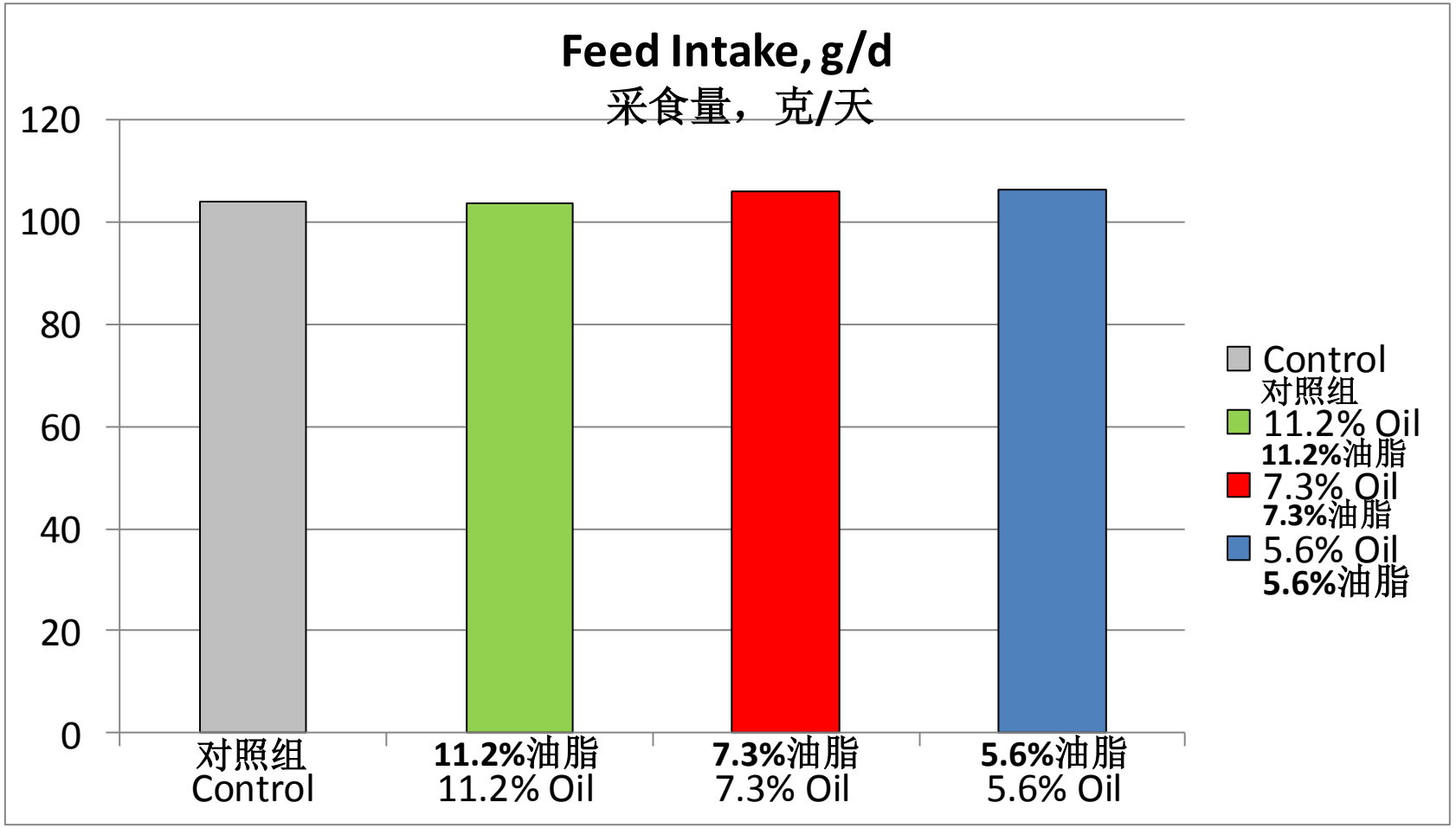
Purdum and Kreifels (2012)

Experimental layer diet formulations
实验性蛋鸡日粮配方

Ingredient 原料	Control (0% DDGS) 对照组（不使用DDGS）	Reduced-oil DDGS Diets 低脂DDGS日粮
Corn 玉米	55.7	45.9
Soybean meal (47%) 豆粕	29.5	19.1
DDGS	0.0	20.0
Corn oil 玉米油	2.83	3.02
Limestone 石粉	9.62	9.92
Dicalcium phosphate 磷酸氢钙	1.58	1.21
Salt 食盐	0.42	0.32
L-lysine L-赖氨酸	0.03	0.21
DL-methionine DL-蛋氨酸	0.17	0.16
VTM premix 维生素预混料	0.20	0.20
Calculated M.E. (kcal/kg) 代谢能预测值	2,860	2,860
Protein, % 蛋白质	18.0	18.0

No ME adjustments were made for medium and low oil DDGS diets.
没有对中脂和低脂DDGS代谢能进行调整
Purdum and Kreifels (2012)

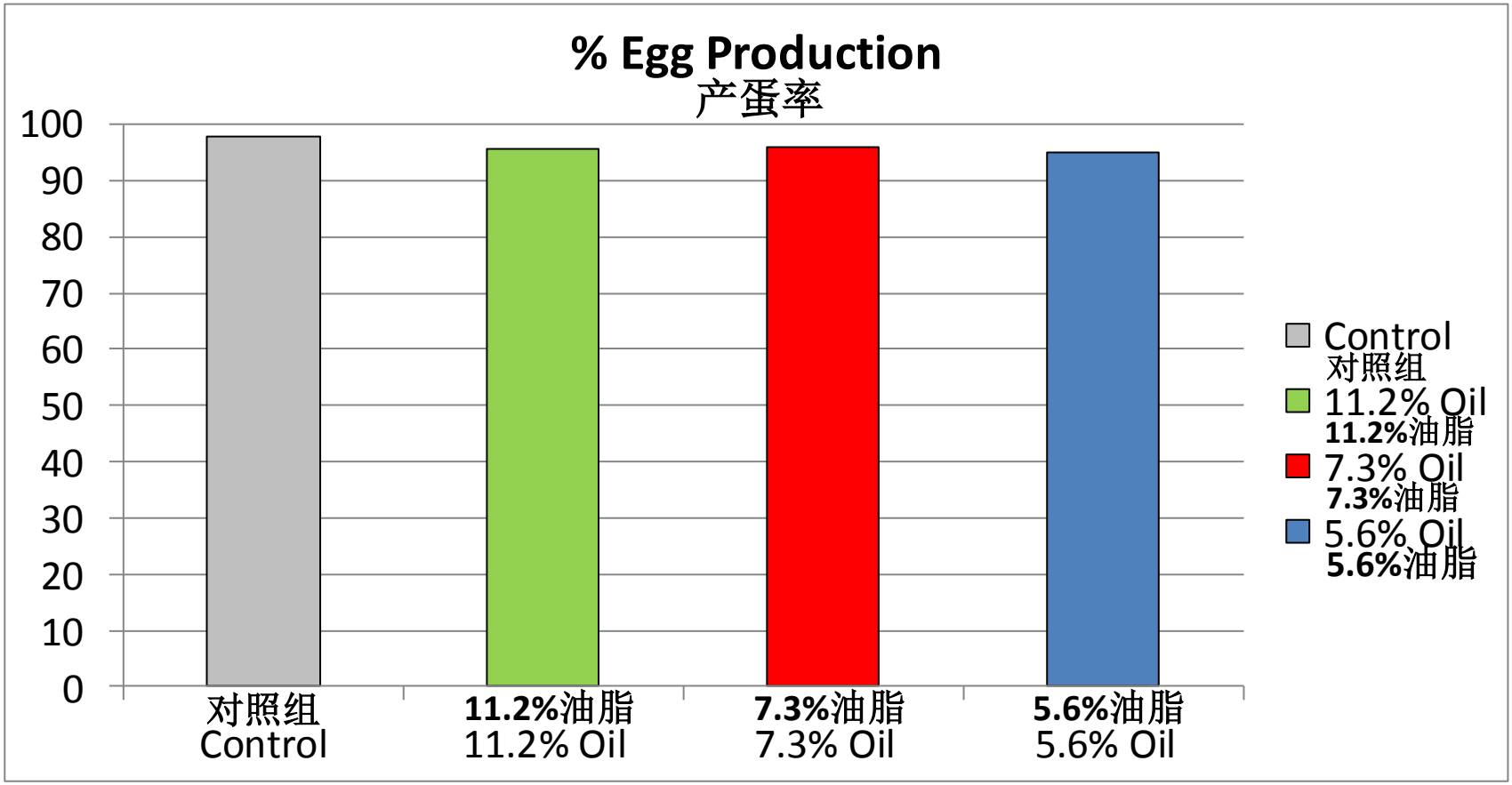
Effect of reduced-oil DDGS on laying hen feed intake
低脂DDGS对产蛋鸡采食量的影响



Purdum and Kreifels (2012)

Feeding reduced-oil DDGS had no effect on % egg production

饲喂低脂DDGS对产蛋率没有影响



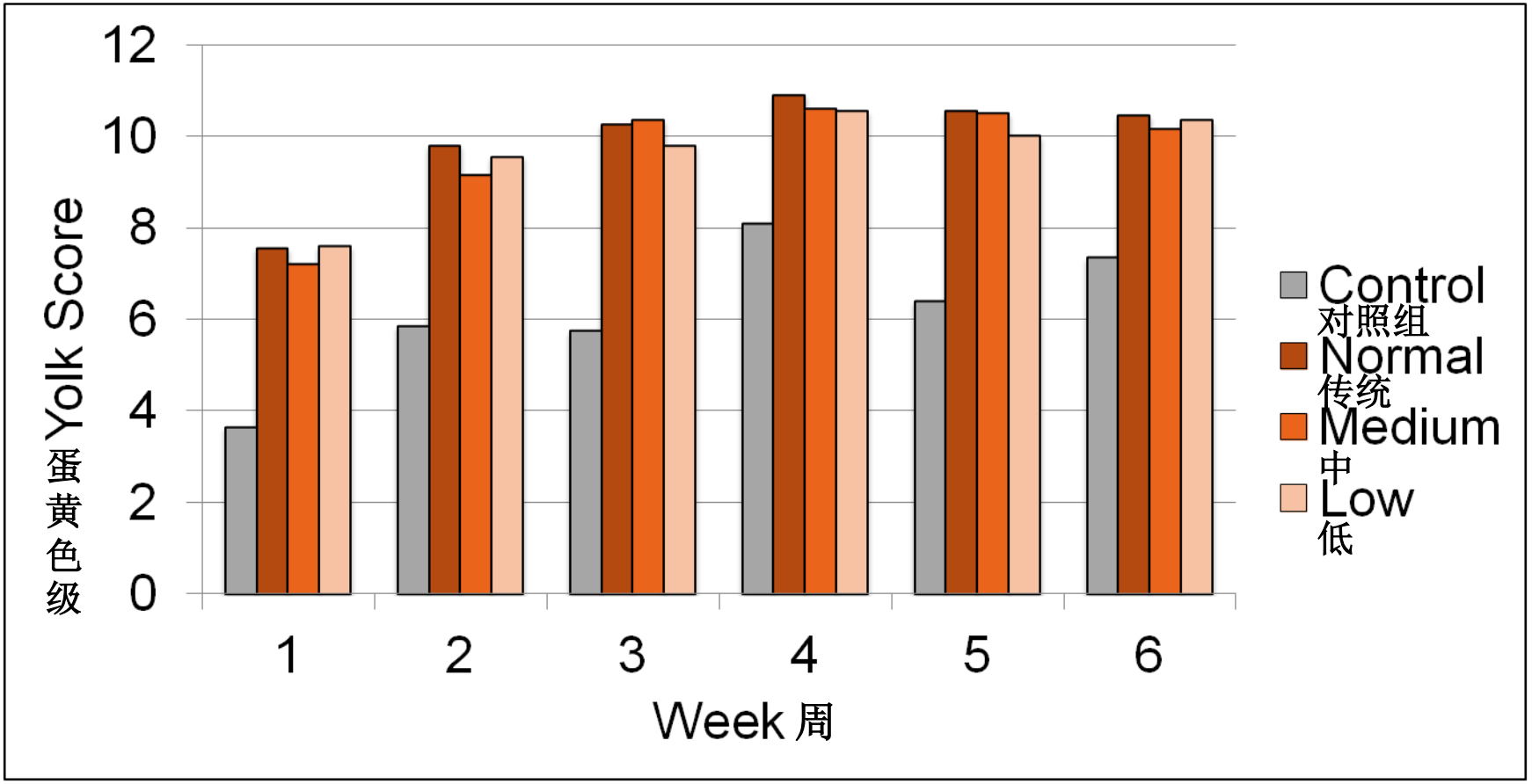
Purdum and Kreifels (2012)

Feeding reduced-oil DDGS had no effect on egg weight and feed conversion
饲喂低脂DDGS对产蛋重和饲料转化率没有影响

Diet 日粮	Hen Body Weight, g 母鸡体重，克	Egg Weight, g 蛋重，克	Feed Conversion (g feed:g egg) 料重比(克料:克蛋)
Control 对照组	1,515	58.8	1.76
11.2% Oil DDGS 11.2%油脂DDGS	1,541	59.0	1.77
7.3% Oil DDGS 7.3%油脂DDGS	1,506	59.9	1.76
5.6% Oil DDGS 5.6%油脂DDGS	1,530	59.7	1.75

Source: Purdum and Kreifels (2012)

Effect of reduced-oil DDGS on egg yolk color (Roche Scores)
低脂DDGS对蛋黄颜色的影响（罗氏色级）



Purdum and Kreifels (2012)

Effect of Reduced-Oil DDGS on Broiler Growth Performance

低脂DDGS对肉鸡生长性能的影响

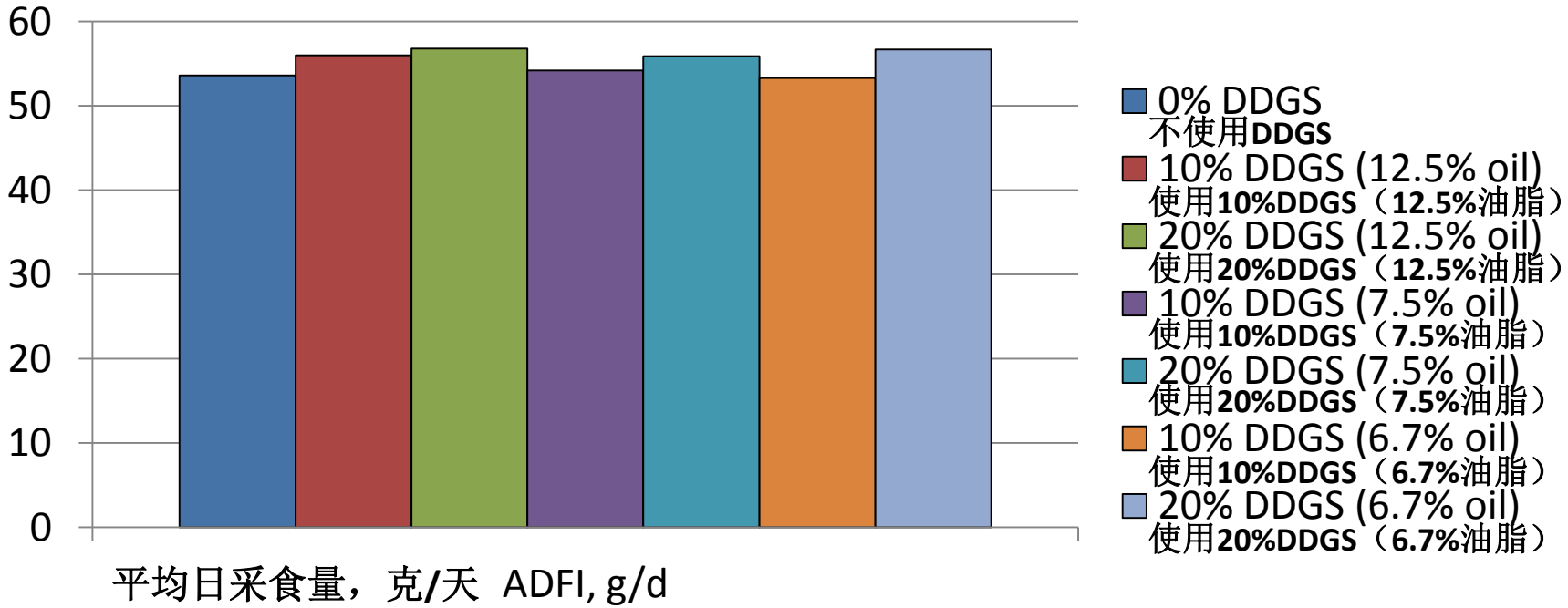
DDGS nutrient profiles
DDGS营养成分组成

Nutrient 营养成分	Normal DDGS 传统DDGS	Reduced-Oil DDGS 1 低脂DDGS 1	Reduced-Oil DDGS 2 低脂DDGS 2
Crude protein, % 粗蛋白	27.7	27.8	28.8
Crude fat, % 粗脂肪	**12.5**	**7.5**	**6.7**
Crude fiber, % 粗纤维	6.1	6.3	7.4
Ash, % 灰分	5.6	7.2	6.6
Gross energy, kcal/kg 总能，千卡/公斤	4,860	4,520	4,480
TME_n, kcal/kg 氮校正真代谢能 千卡/公斤	3,150	2,940	2,910

Guney et al. (2013)

Effects of feeding DDGS sources of variable oil content on ADFI of broilers (0 to 18 days of age)

饲喂不同含量的油脂对DDGS对肉鸡平均日采食量的影响（0到18天日龄）



Diets were formulated to be isocaloric using *in vivo* determined TME values for DDGS sources and digestible amino acids using coefficients from Ajinomoto Heartland (2004) for corn and soybean meal and Batal and Dale (2006) for DDGS.

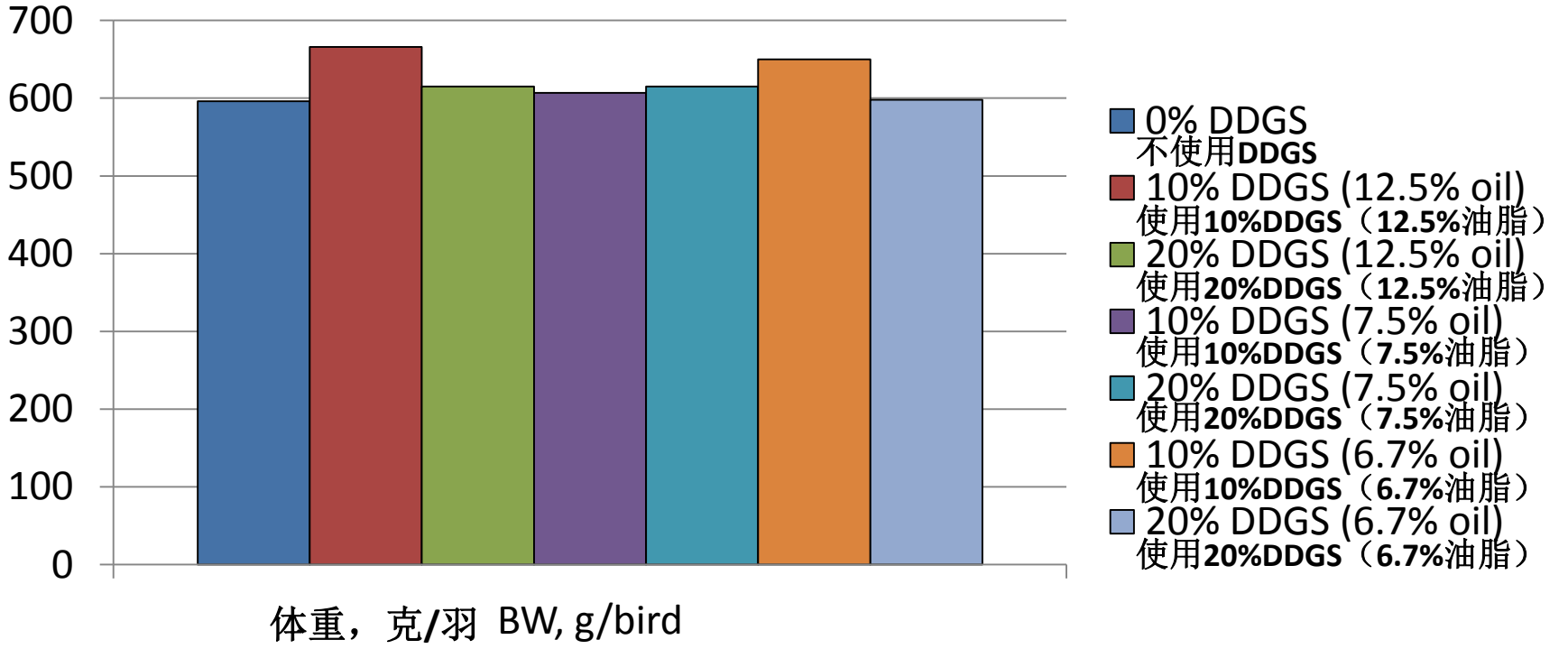
等热量日粮配方，用体内法计算DDGS的真代谢能，用Ajinomoto Heartland (2004)的系数计算玉米和豆粕的可消化氨基酸，用Batal and Dale (2006)的系数计算DDGS的可消化氨基酸。

No effect of DDGS source or level (P > 0.05)　DDGS种类和油脂水平无影响

Guney et al. (2013)

Effects of feeding DDGS sources of variable oil content on body weight of broilers (0 to 18 days of age)

饲喂不同含量的油脂DDGS对肉鸡体重的影响（0到18天日龄）



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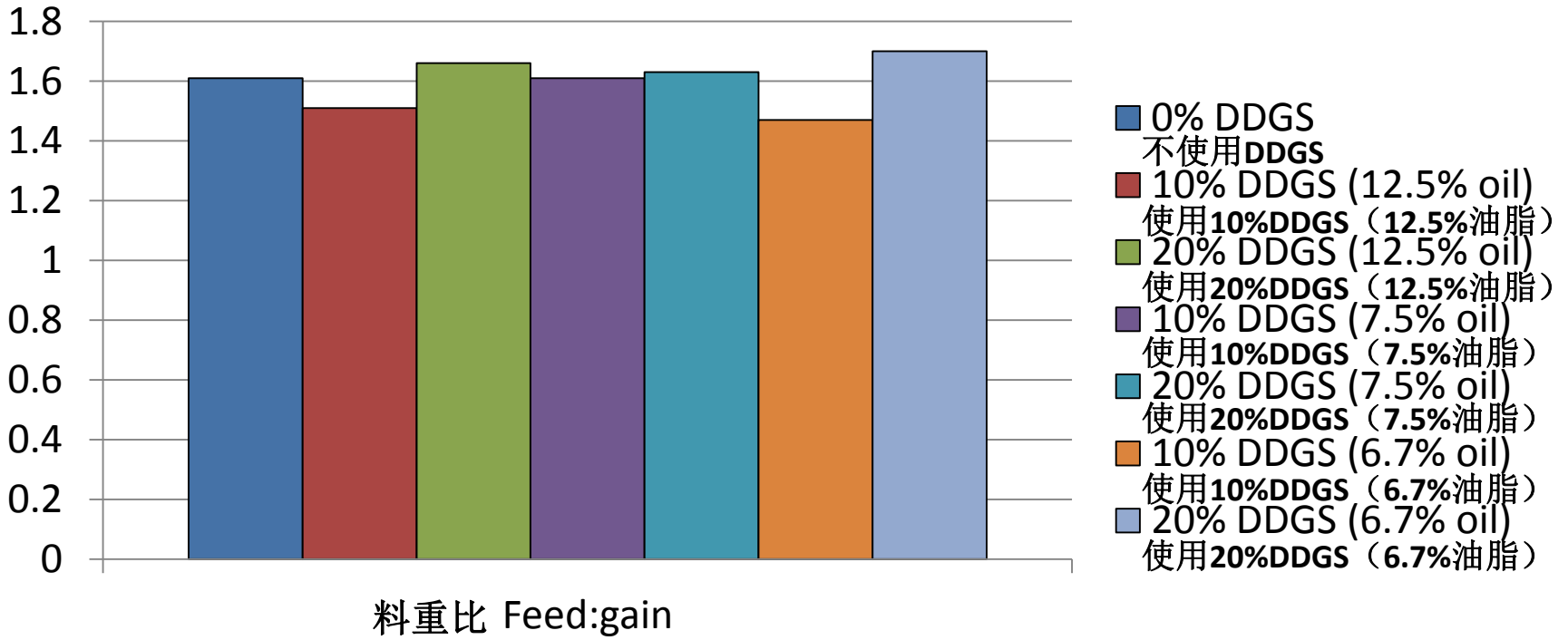
Chicks fed 12.5% and 6.7% oil DDGS sources added at 10 or 20% of the diet performed well.
肉鸡饲喂12.5%和6.7%油脂DDGS，在日粮添加比例为10%或20%时，鸡只性能好。

Guney et al. (2013)

Effects of feeding DDGS sources of variable oil content on feed/gain of broilers (0 to 18 days of age)
饲喂不同油脂含量DDGS对肉鸡料重比的影响（0到18天日龄）



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Chicks fed 10% DDGS of any source had improved F:G compared with 20% dietary inclusion.
肉鸡日粮中使用10%的DDGS比使用20%的DDGS时料重比更低，任何油脂比例DDGS均适用。

Guney et al. (2013)

Conclusions 结论

- Oil content of reduced-oil DDGS is a **poor predictor** of AME_n content.
  用低脂DDGS中的油脂比例无法准确估算氮校正表观代谢能
- Reduced-oil DDGS provides **equivalent layer performance** to “typical” DDGS.
  饲喂低脂DDGS和传统DDGS的蛋鸡性能相同
- Hens **slightly increase feed intake** (2 to 2.4 g/d) when fed reduced-oil DDGS diets.
  饲喂低脂DDGS日粮的母鸡采食量稍有增加（2到2.4克/天）
- Gross energy content of reduced-oil DDGS is lower than traditional DDGS, but there are **no negative effects** on growth performance of broilers when the **energy requirement is met using a supplemental fat source.**
  低脂DDGS的总能量比传统DDGS低，但是如果**添加其它来源脂肪使能量需求得到满足**，则对肉鸡的生长性能**没有负面影响**
  - Adding up to 20% reduced-oil DDGS to broiler diets has no detrimental effect on growth performance compared to feeding a corn-soybean meal diet.
    跟饲喂玉米-豆粕日粮相比，在肉鸡日粮中使用高达20%的低脂DDGS对生长性能没有负面影响
- AME_n of reduced-oil DDGS for poultry can be estimated by using the following equation:
  禽料中低脂DDGS的氮校正表观代谢能可以用如下公式计算：

AME_N kcal/kg = 3,673 - (121.35 x crude fiber) + (51.29 x ether extract) - (121.08 x Ash)
氮校正表观代谢能 千卡/公斤= 3,673 - (121.35 x 粗纤维) + (51.29 x 粗脂肪) - (121.08 x 灰分)

www.ddgs.umn.edu