

# Use of Feed Additives in Diets for Pigs

## 猪日粮中添加剂的使用

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# Overview 总览

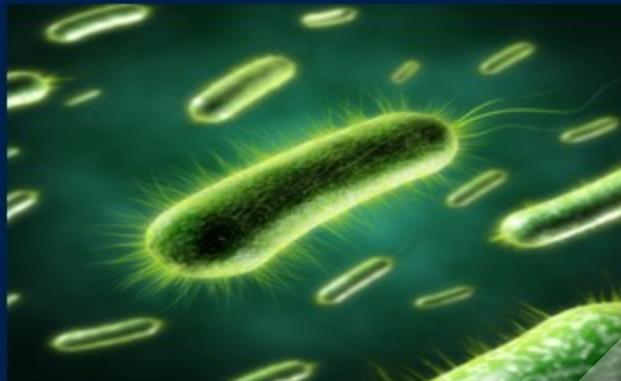
Copper and  
Zinc  
铜和锌

Prebiotics  
and direct fed  
microbials  
益生元和益生  
菌

Nucleotides  
and Plant  
Extracts  
核苷酸和植物  
提取物



# General Mode of Action 作用机理



Modify Gut  
Microbiota

调节肠道菌群

Improved  
Intestinal  
Health

改善肠道健康

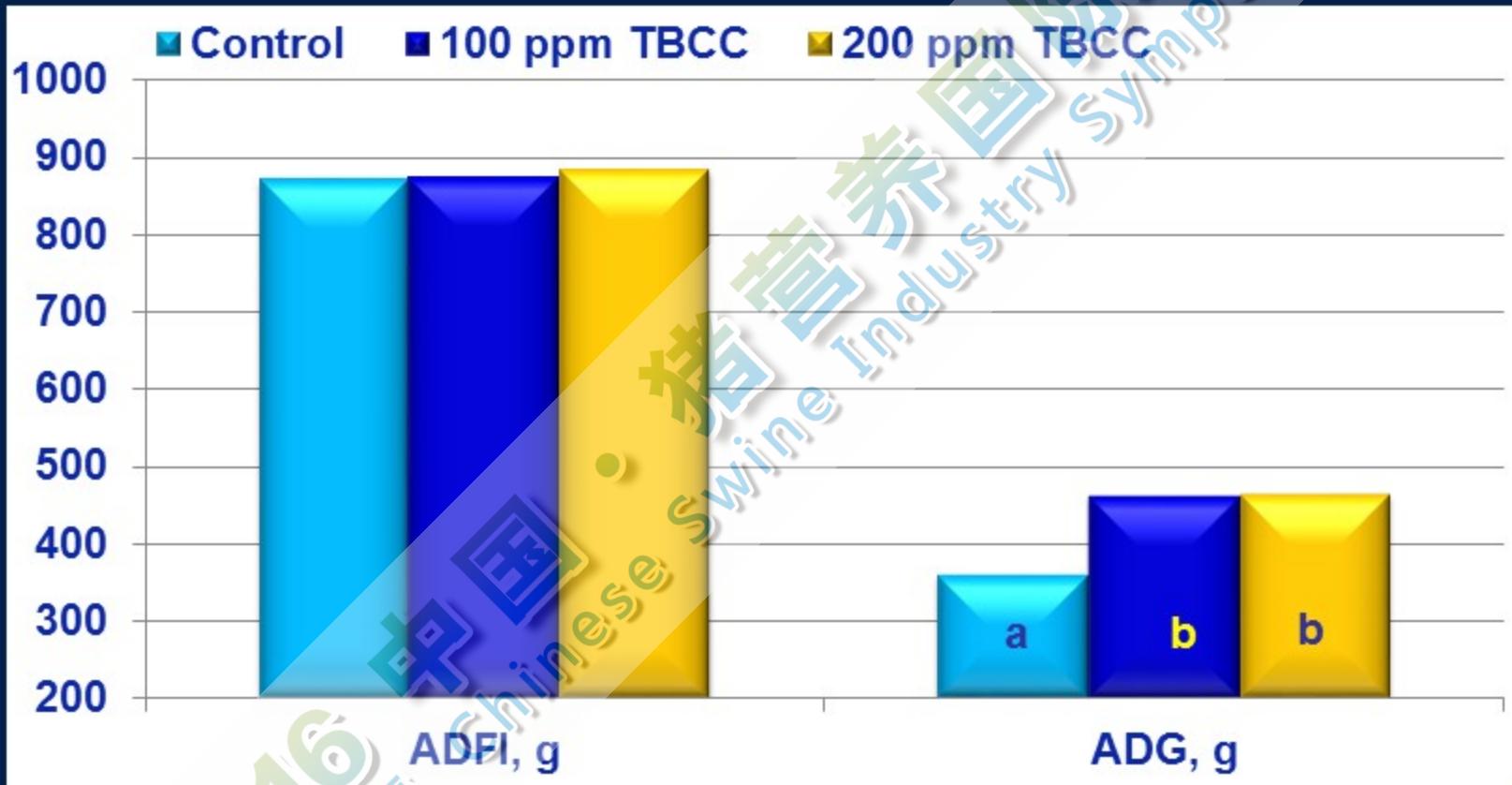


# Copper and Zinc, ADG, g/d

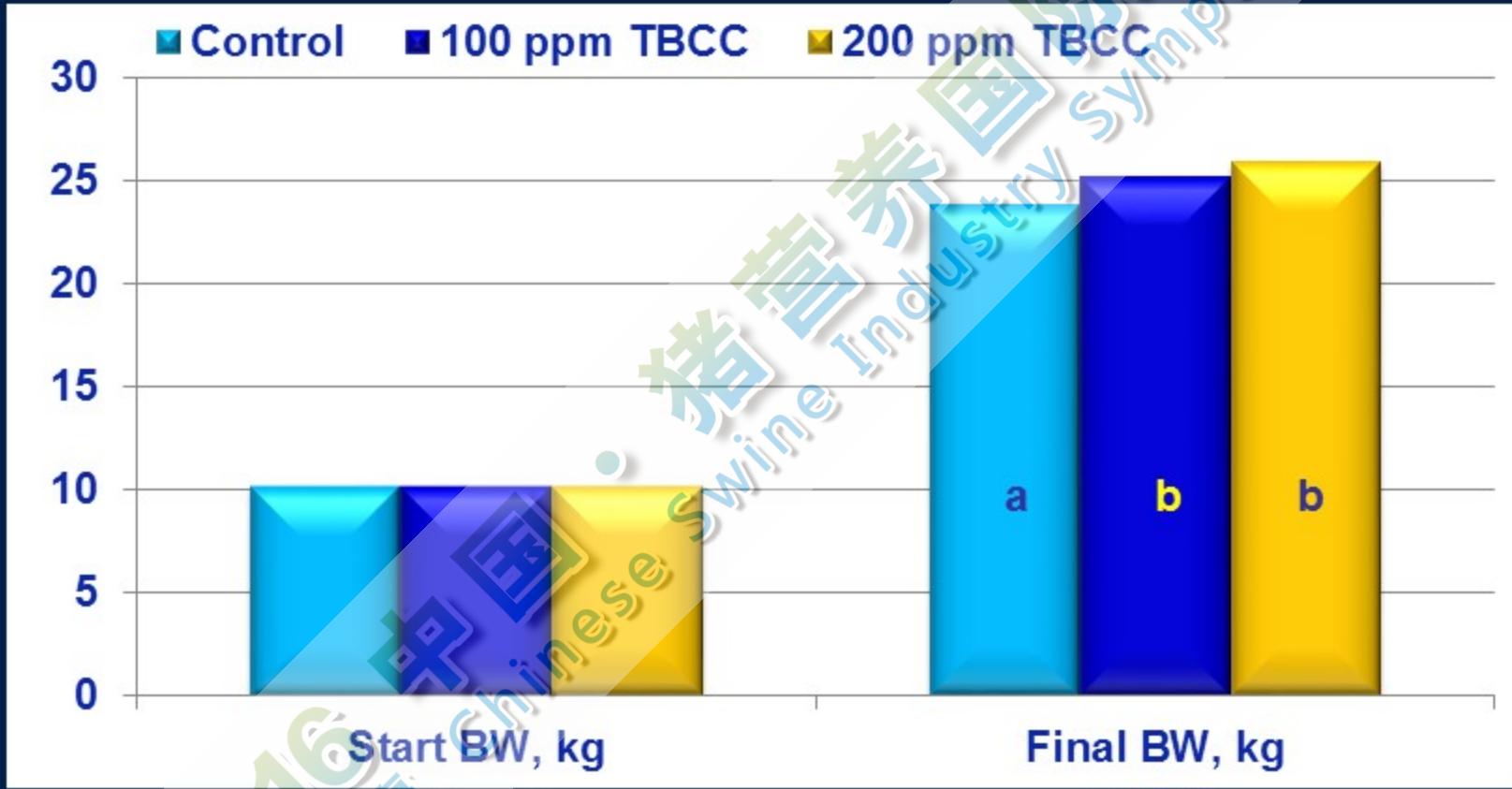


Hui et al., 2000

# Effect of Tribasic Copper Chloride 碱式氯化铜

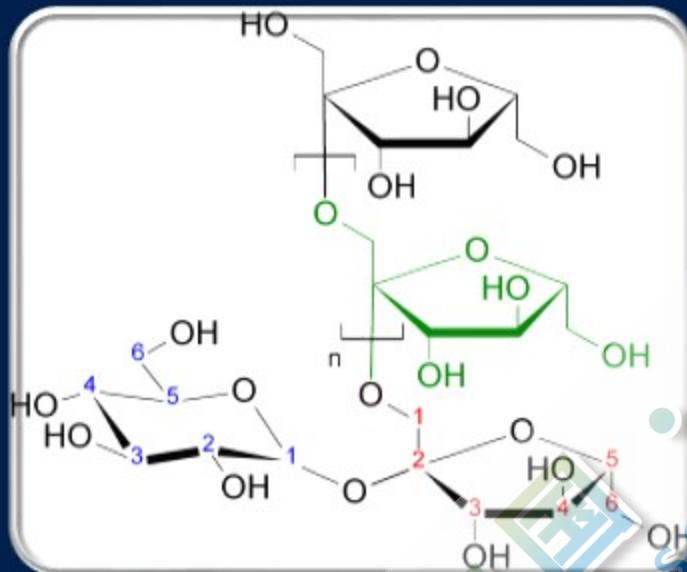


# Effect of Tribasic Copper Chloride 碱式氯化铜



# Prebiotics and Probiotics

益生元和益生菌

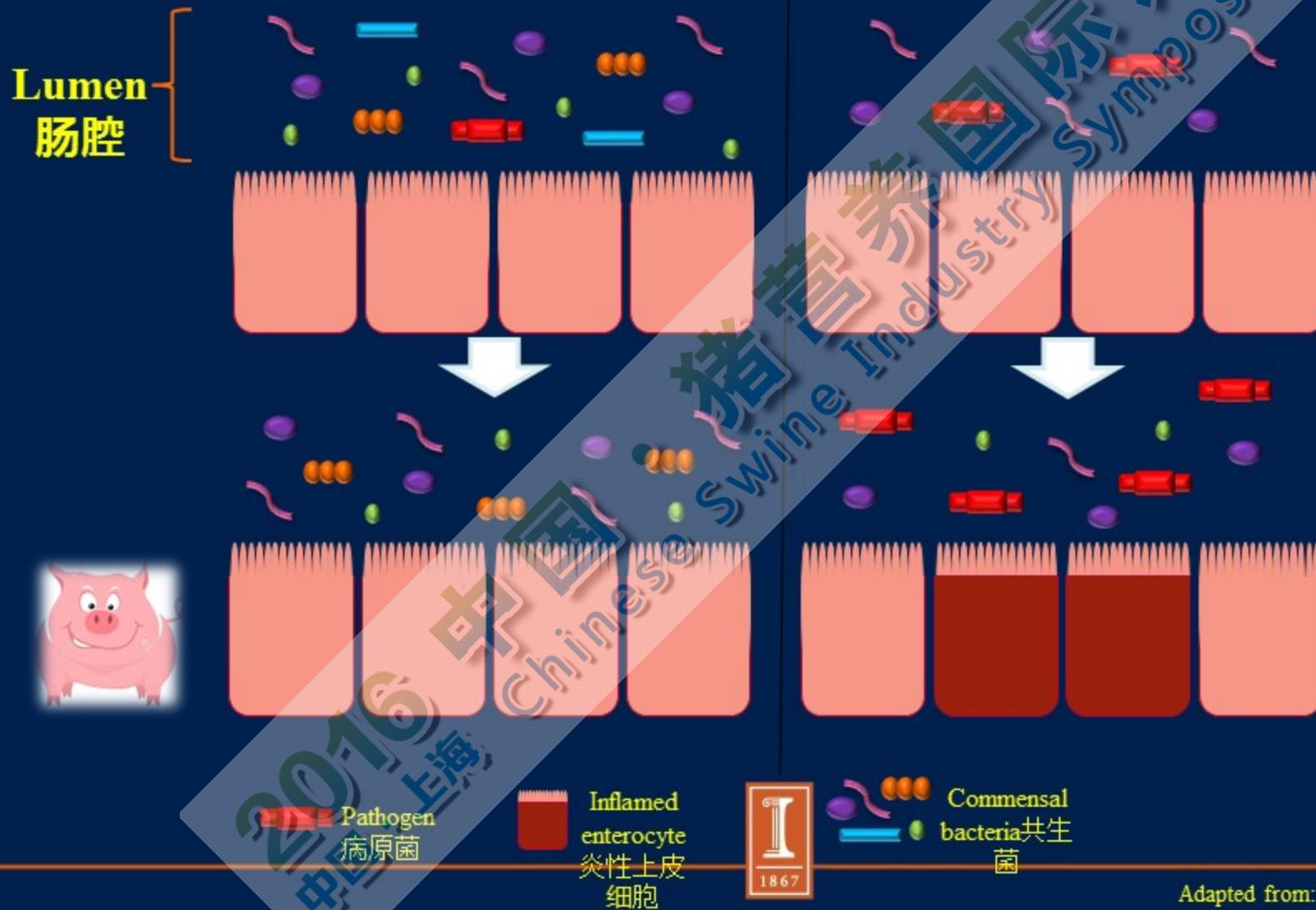


2016  
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High microbial diversity  
高菌群多样性

Low microbial diversity  
低菌群多样性



Adapted from: Fouhse, et al., 2016

# Carbohydrates, overview

## 碳水化合物总览

### Disaccharides

二糖

Sucrose 蔗糖

Lactose 乳糖

Maltose 麦芽糖

Celllobiose 纤维二糖

Gentiobiose 龙胆二糖

### Monosac.

### Oligosaccharides

寡糖

$\alpha$ -GOS 低聚半乳糖

FOS 低聚果糖

TOS 低聚糖

MOS 甘露寡糖

### Polysaccharides

多糖

Starch, Glycogen 淀粉、糖原

Non-starch

polysaccharides

非淀粉多糖



# Mode of action 作用机理

①

Growth of bacteria  
细 菌生长



Lactic + acetic acid  
乳酸 + 乙酸

pH in Intestine  
肠道pH



②

Fermentation  
发 酵



SCFA  
↑ 短链脂 肪酸

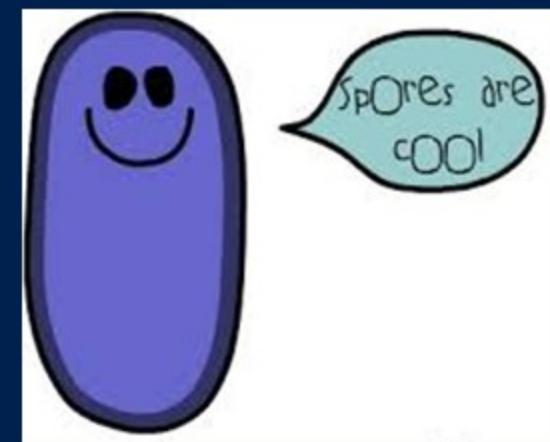
Pathogens  
病 原 菌

2016  
中国·上海



# Direct-fed Microbials 益生菌

- Live naturally occurring microorganisms 自然存在的活的微生物
- *Bacillus*-based DFM 芽孢杆菌类益生菌
  - Spore-forming 产芽孢厌氧菌



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# Effect of 3-strain DFM

## 3种益生菌

Low or high fiber diets – d 1 to 42 PW

低或高纤维日粮 - 断奶后1-42天



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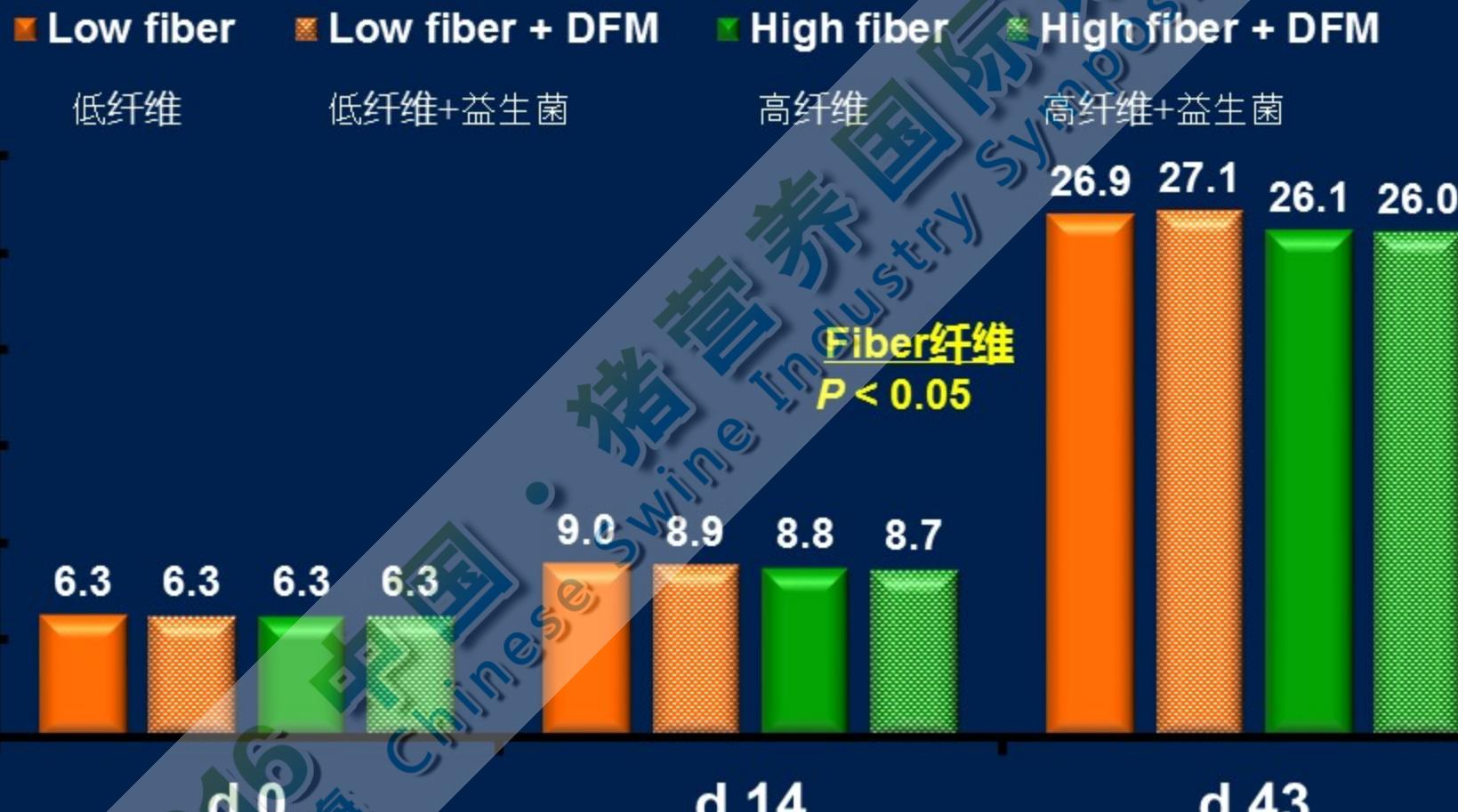
Chinese Swine Industry Symposium



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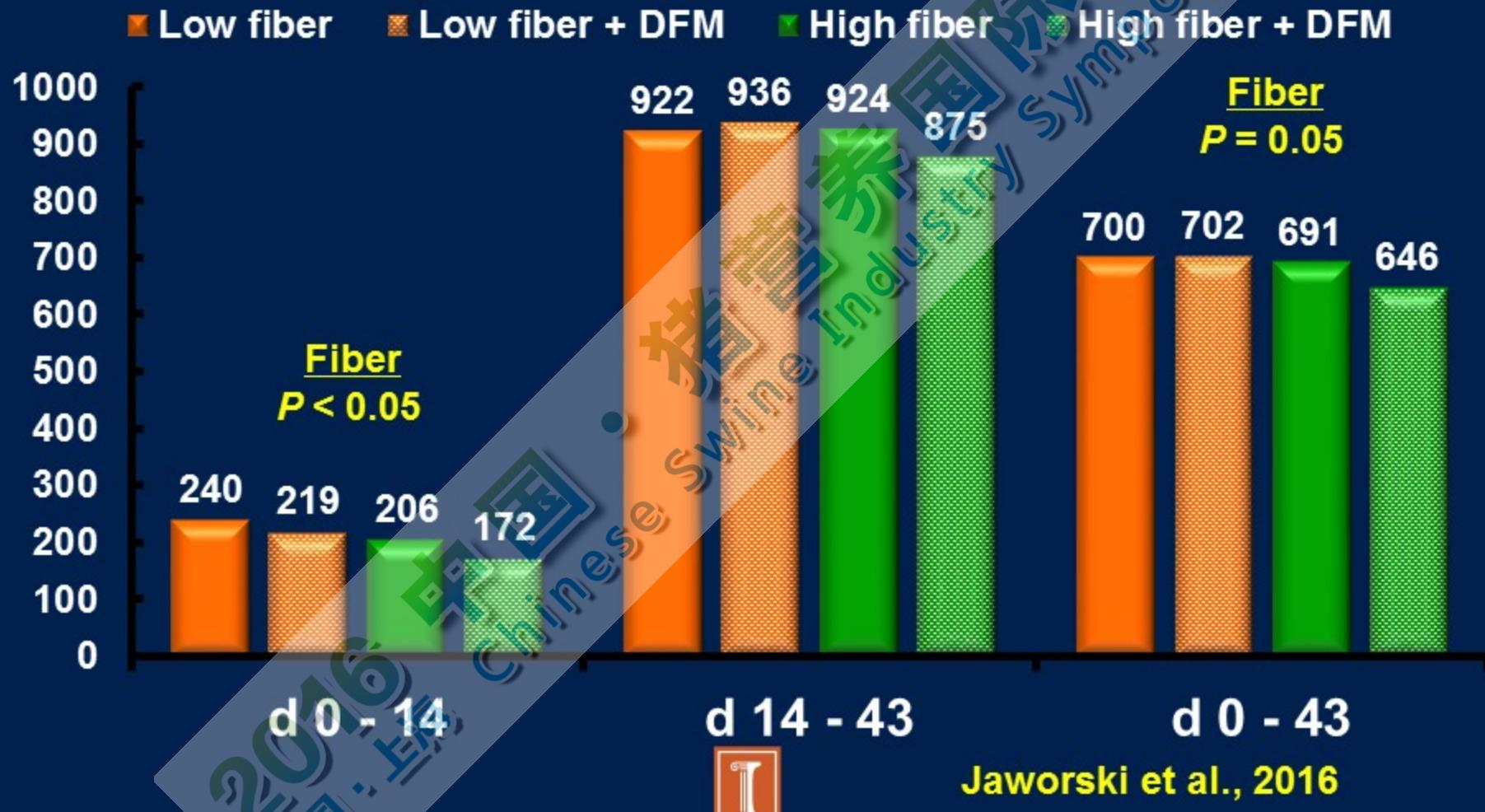
Jaworski et al., 2016

# 体重 Body Weight, kg



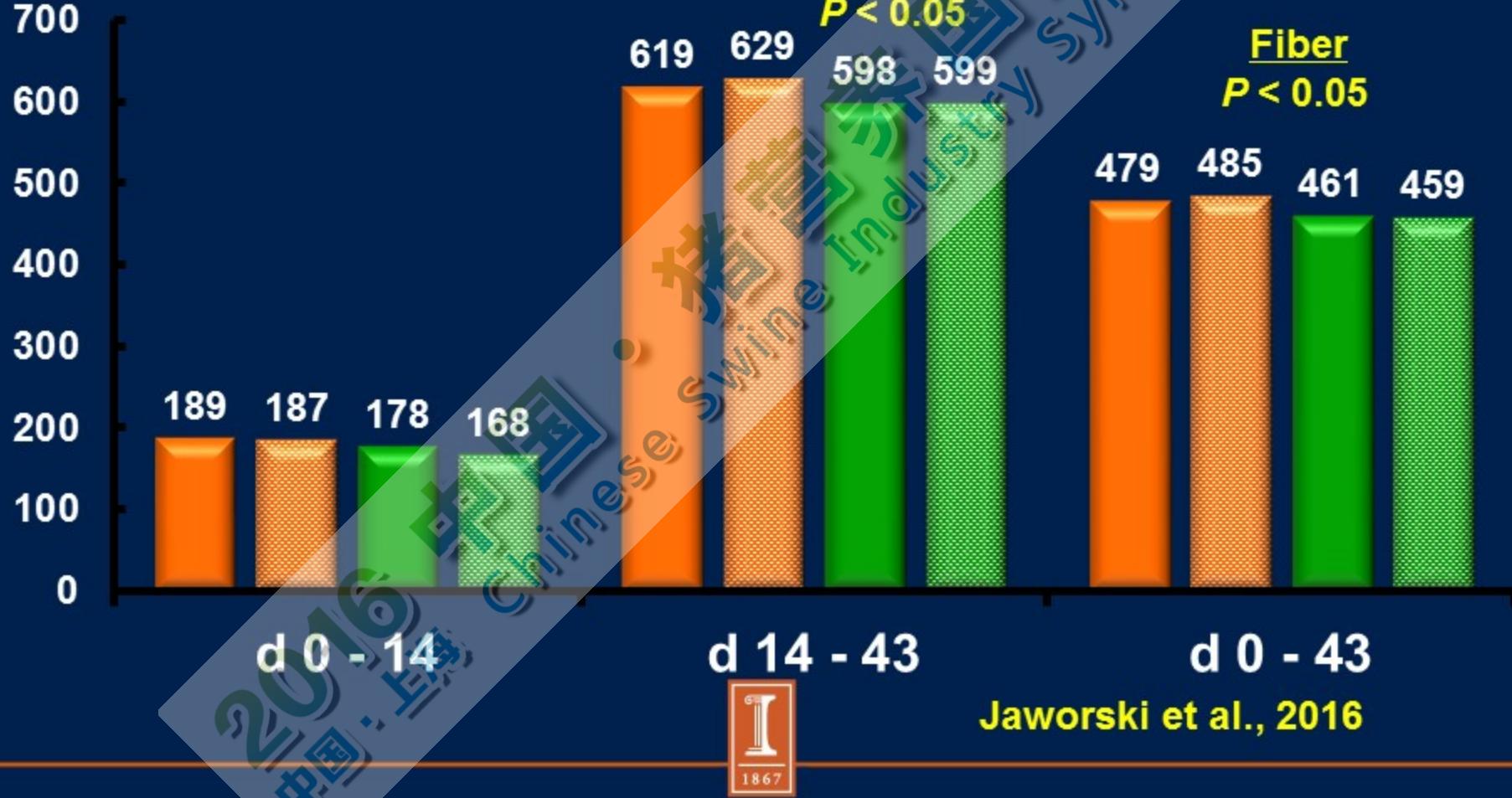
## 采食量

## Average Daily Feed Intake, g/d

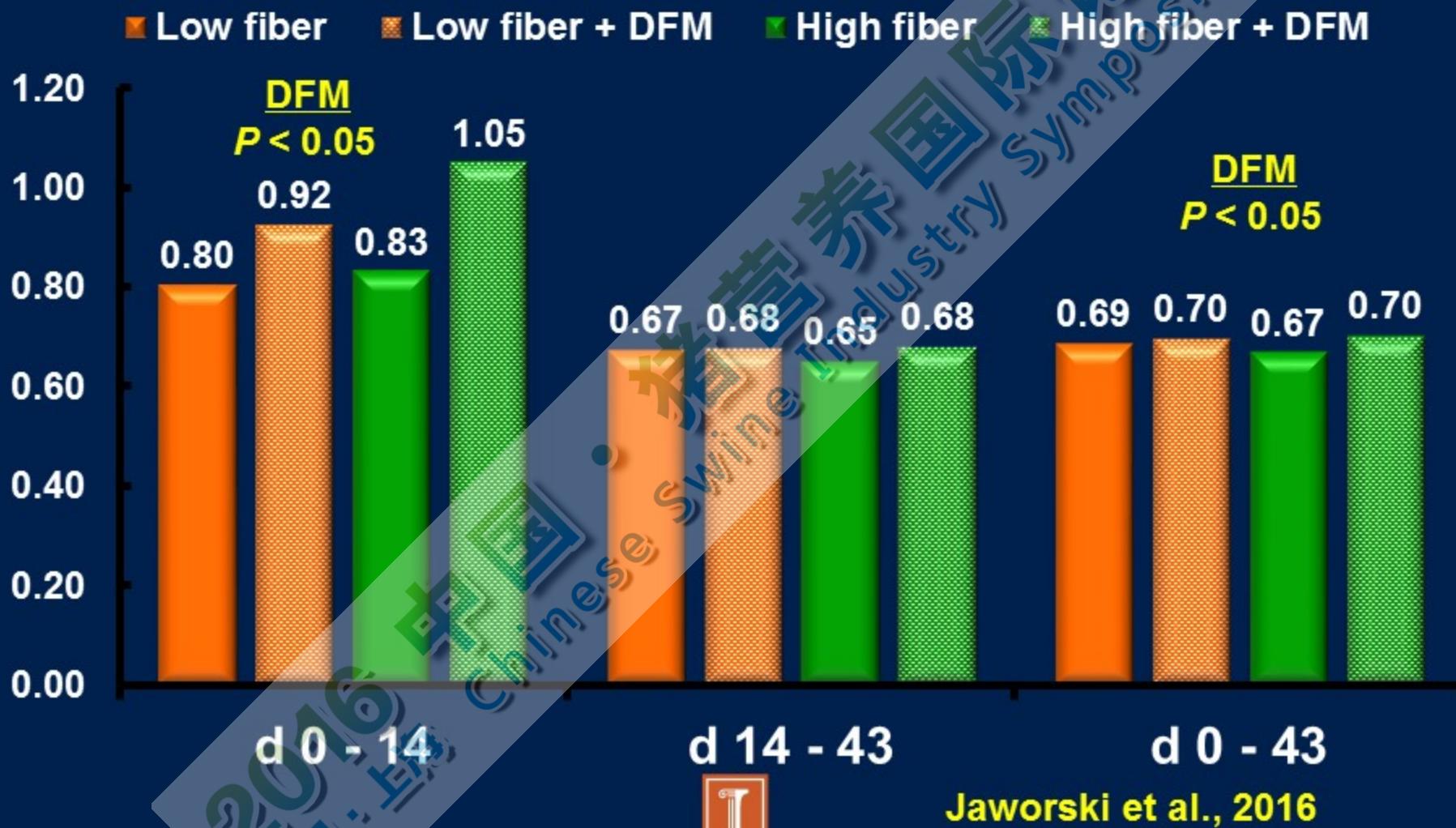


# 日增重 Average Daily Gain, g/d

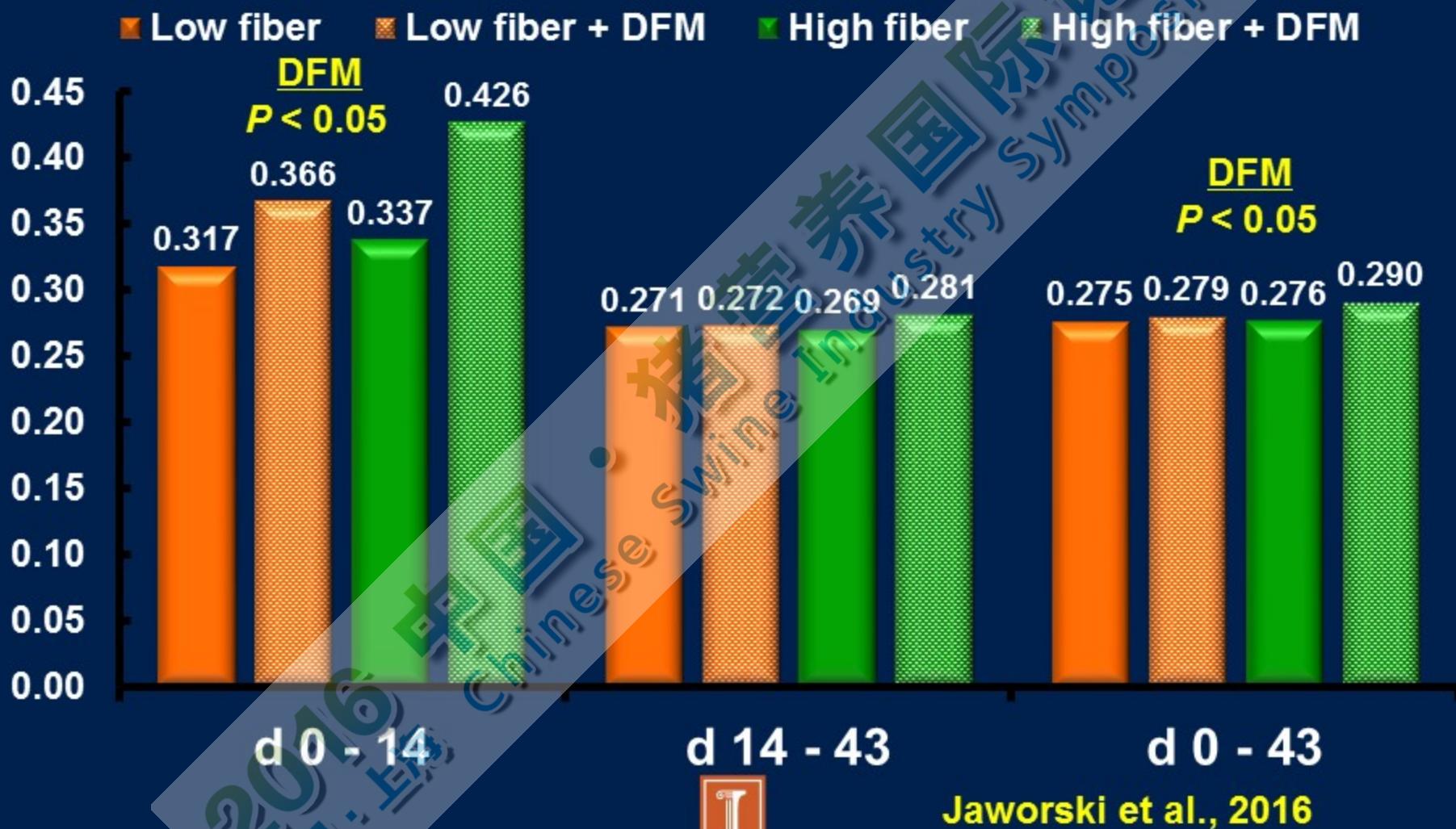
■ Low fiber ■ Low fiber + DFM ■ High fiber ■ High fiber + DFM



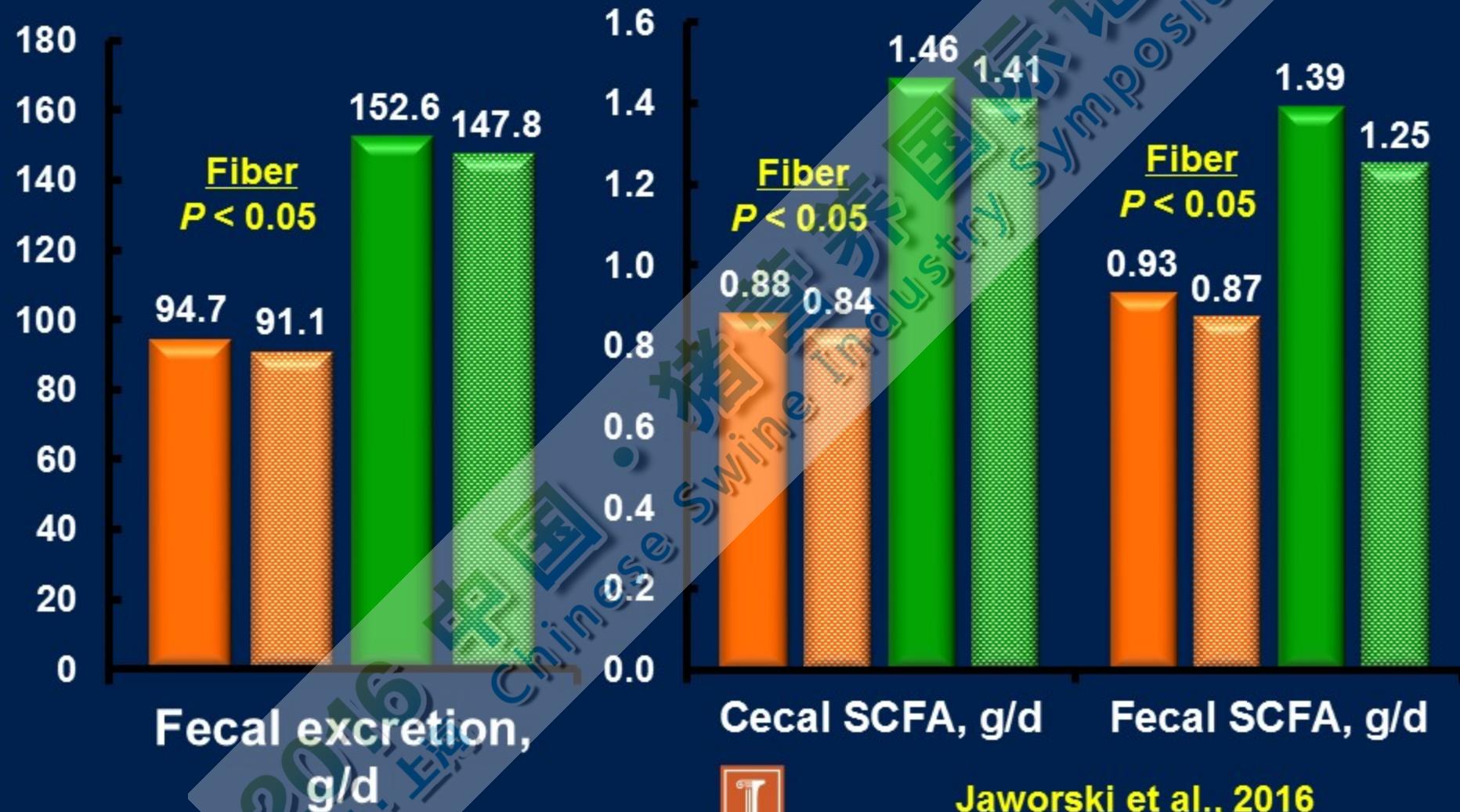
# 肉料比Gain:Feed, g/g



# 增重:净能 Gain:Feed, kg/Mcal NE

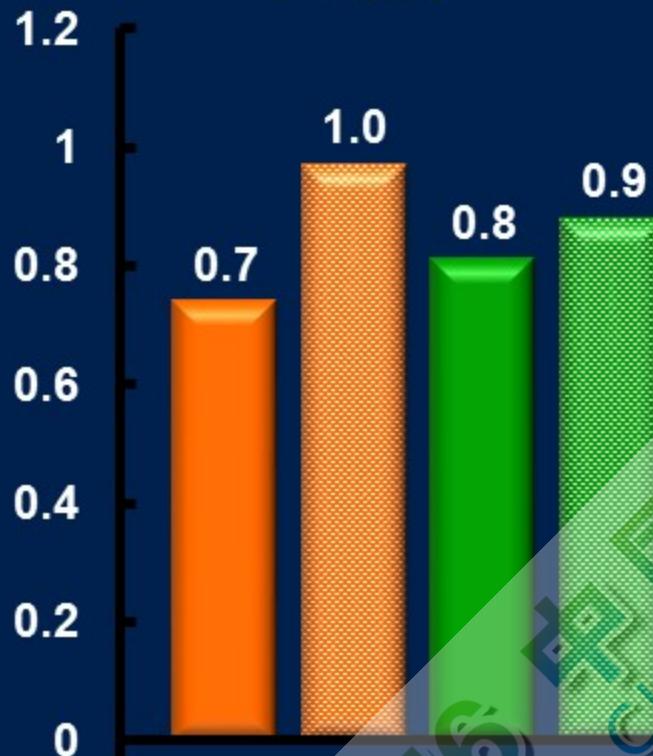


# 短链脂肪酸 SCFA, g/d DMB



# 肝脏基因表达 Liver Gene Expression

DFM,  
 $P < 0.10$



DFM,  
 $P < 0.05$



DFM,  
 $P < 0.01$



CD 147

GLP-2R

Jaworski et al., 2016



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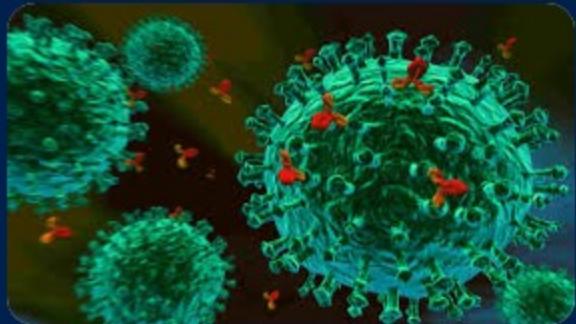
Nucleotides  
核苷酸

2016 中国  
中国·上海 Chinese Nucleotide Industry Symposium



illinois.edu

# Mode of action 作用机理



- ✓ Immune system
- ✓ 免疫系统



- ✓ Microbiota
- ✓ 微生物



- ✓ Intestinal health
- ✓ 肠道健康



# Nucleotide Structure

核苷酸结构



Pyrimidine  
嘧啶

Purine  
嘌呤



# Nucleotide vs. Nucleoside

## 核苷酸 VS. 核苷



NUCLEOTIDE

NUCLEOSIDE

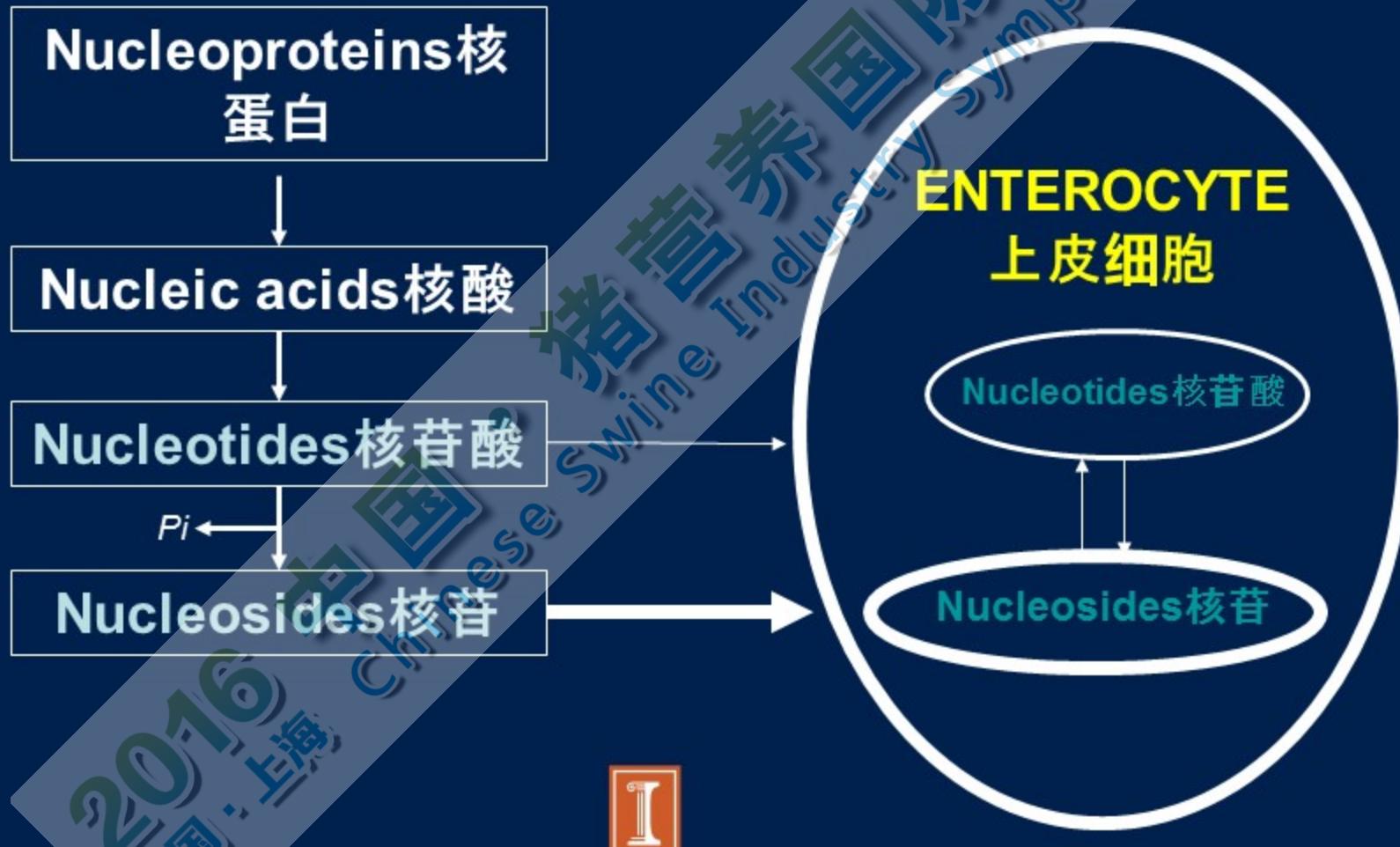
2016  
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核苷酸  
國際研討會



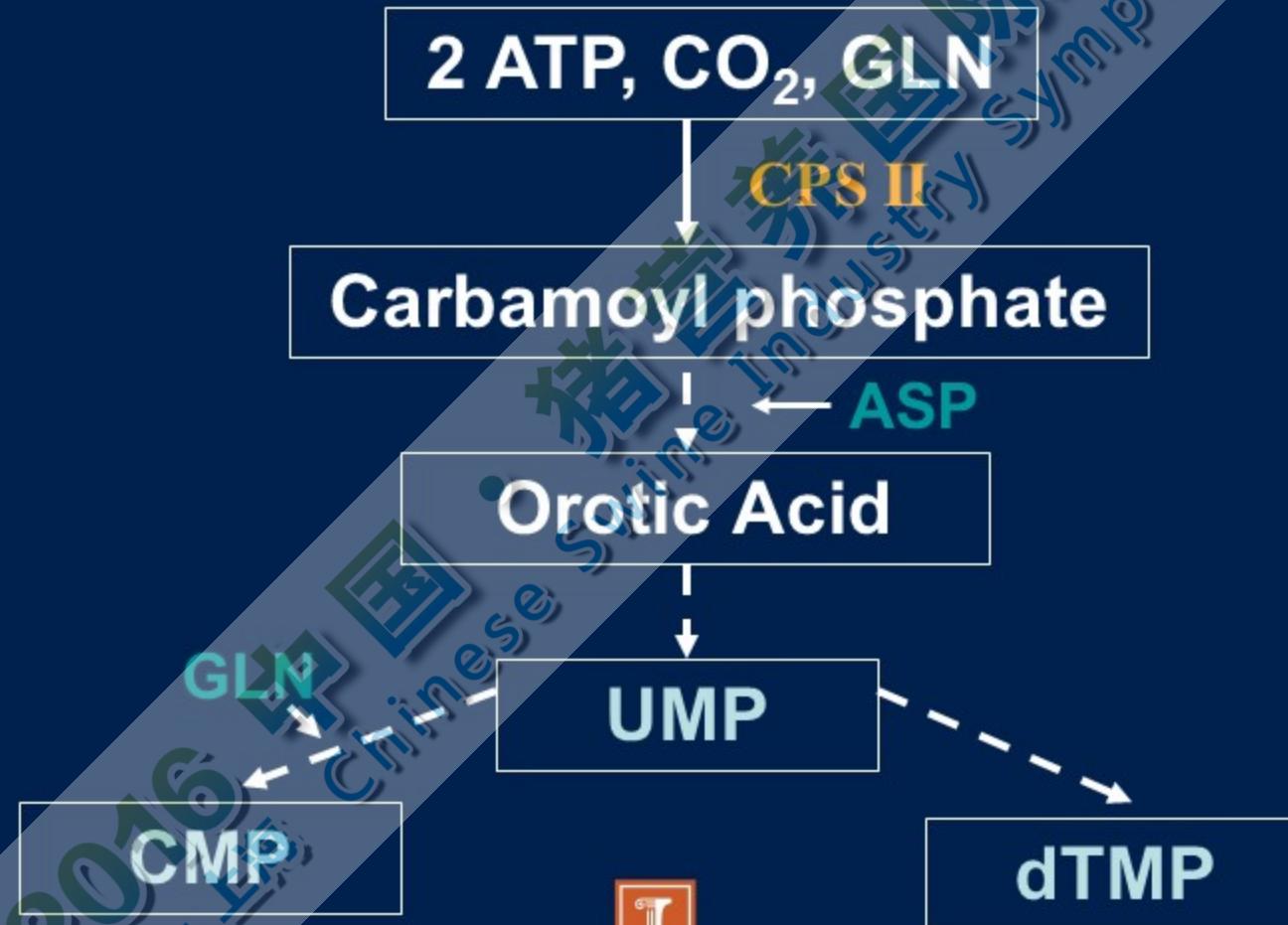
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# Digestion and Absorption

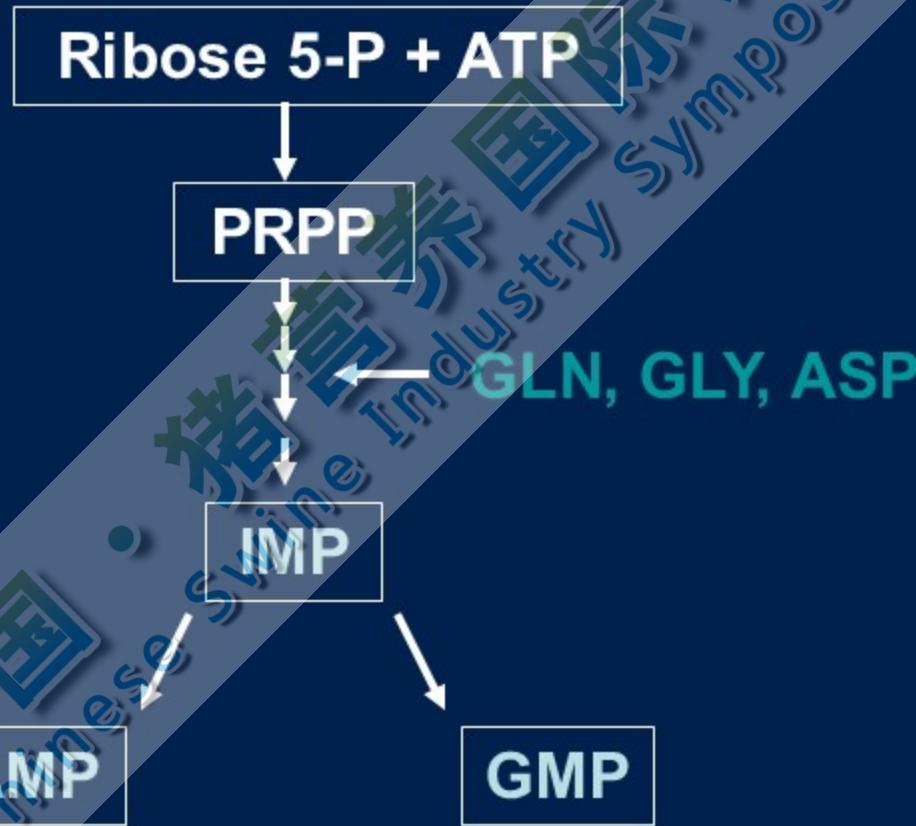
## 消化和吸收



# Pyrimidine Synthesis 嘧啶合成



# Purine Synthesis 嘧呤合成



# Tissue that cannot synthesize Nucleotides

不能合成核苷酸的组织

2

Erythrocytes  
红细胞

1

Brain Cells  
脑细胞

4

Intestinal  
Mucosal Cells  
肠粘膜细胞

3

Bone marrow  
Cells 骨髓细胞



**Immune  
compromised  
animals** 免疫抑  
制动物

**During periods  
of stress** 应激期间

**Rapidly  
dividing cells** 快速增殖细胞

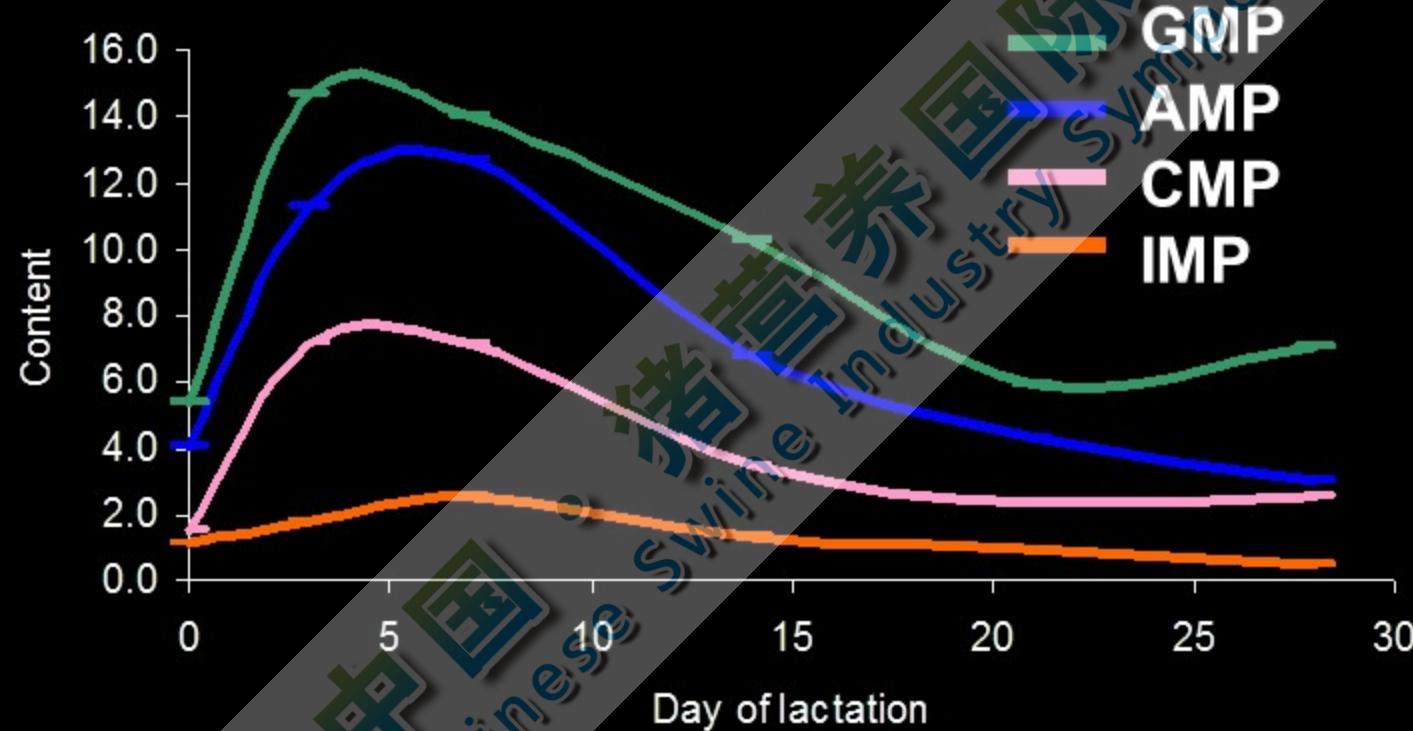
**If energy intake  
is low** 能量摄入量低

2016  
中国·上海



# Nucleotides in Porcine Milk 猪乳

## 中核苷酸含量



2016

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中国

Chinese Swine



# 5' UMP in Porcine Milk

## 猪乳中尿苷酸含量



Mateo et al., 2005a



# Nucleotides in Starter Diets and Milk (ppm, DM-basis)

## 教槽料和猪乳中核苷酸含量

Item	AMP	CMP	GMP	IMP	UMP
Sow Milk	118	56	186	24	2,335
Starter diet	6.5	58.9	2.03	4.33	1.00

Stein and Mateo, 2005



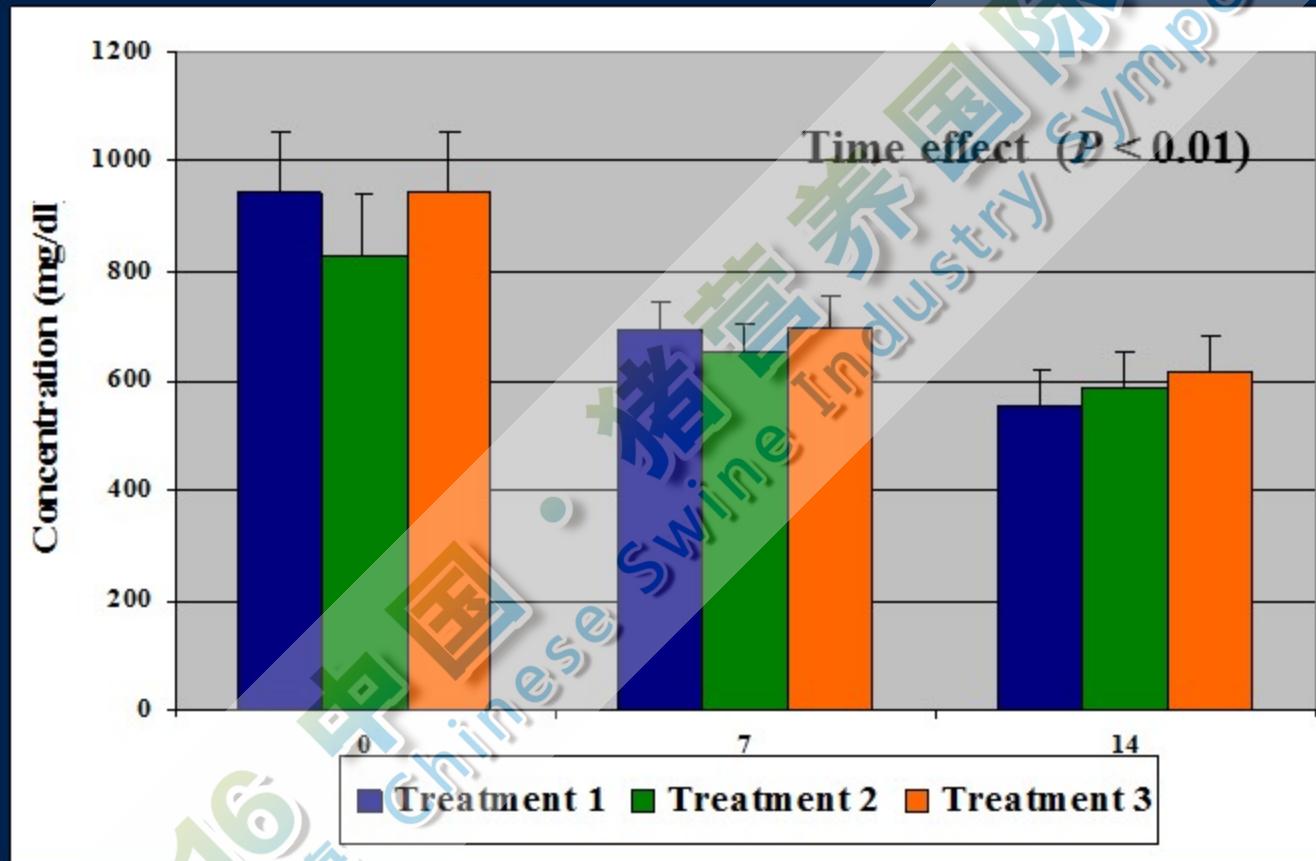
# Nucleotides for pigs

Control, no  
nucleotides  
added  
空白对照组

Low  
nucleotides,  
30% of sow  
milk  
低核苷酸组, 含  
量为猪乳中的  
30%

High  
nucleotides,  
150% of sow  
milk  
高核苷酸组, 含  
量为猪乳的  
100%

# Serum IgG 血漿 IgG

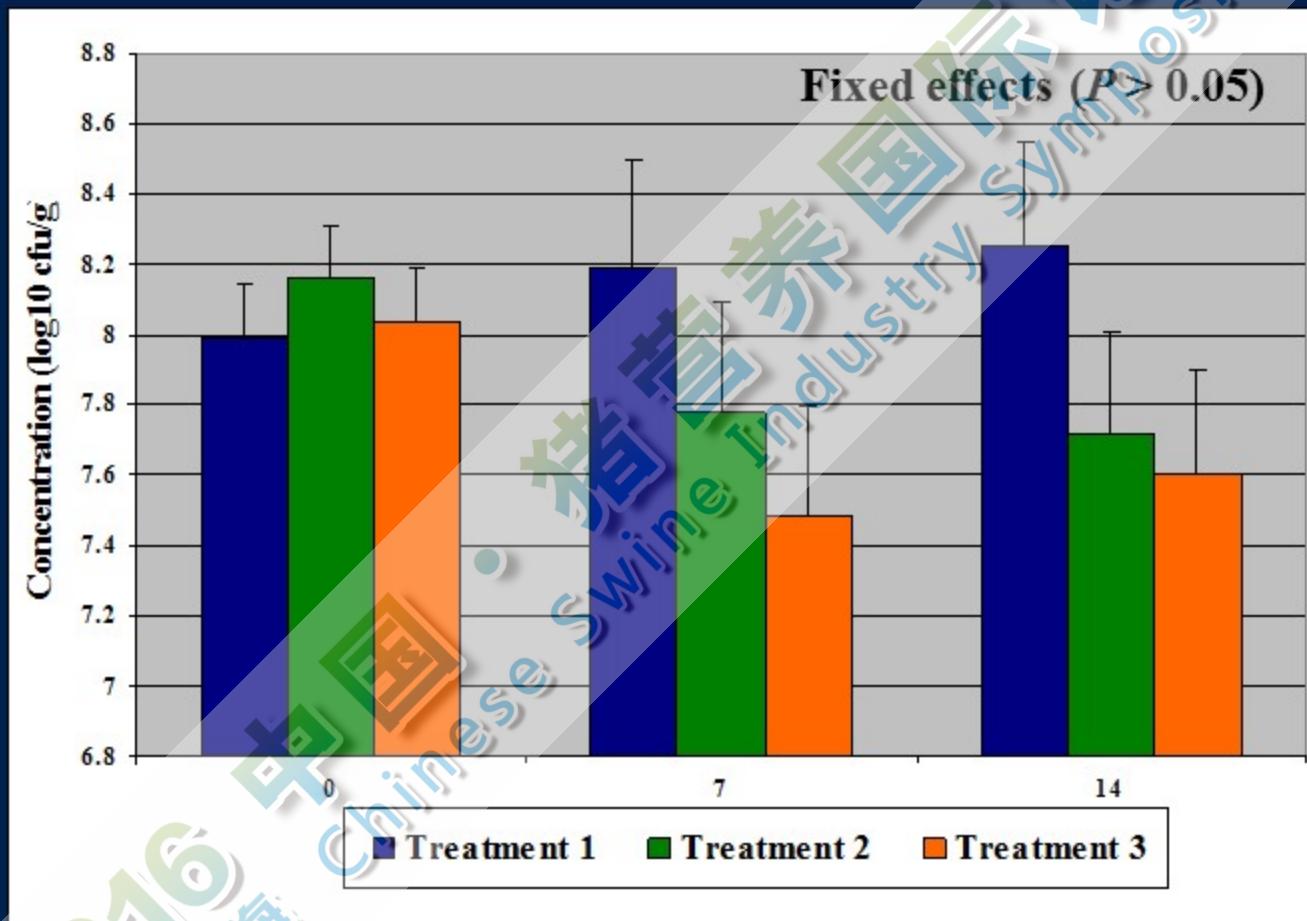


1867

1867

Mateo et al., 2005b

# Total Coliforms 菌落总数

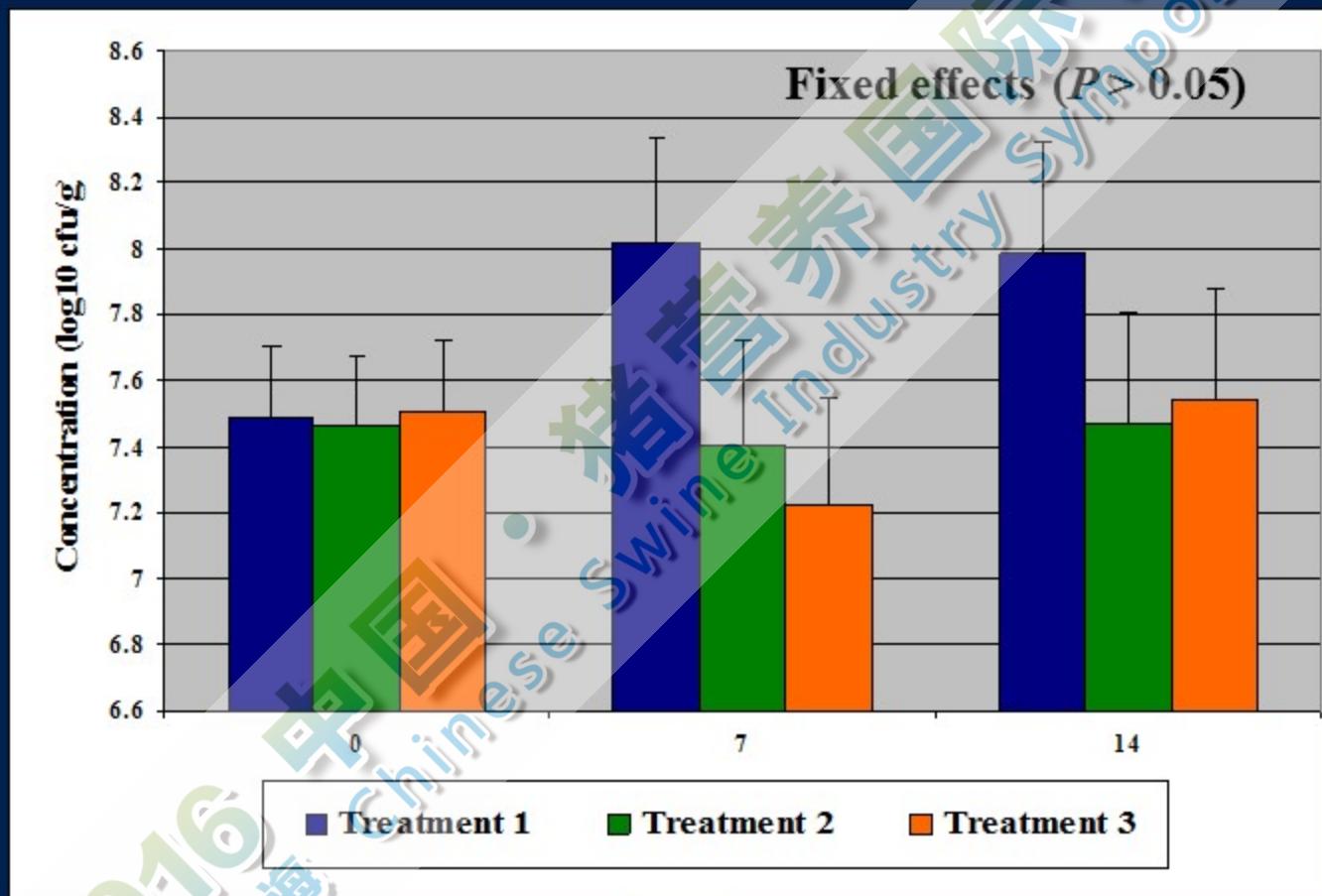


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Mateo et al., 2005

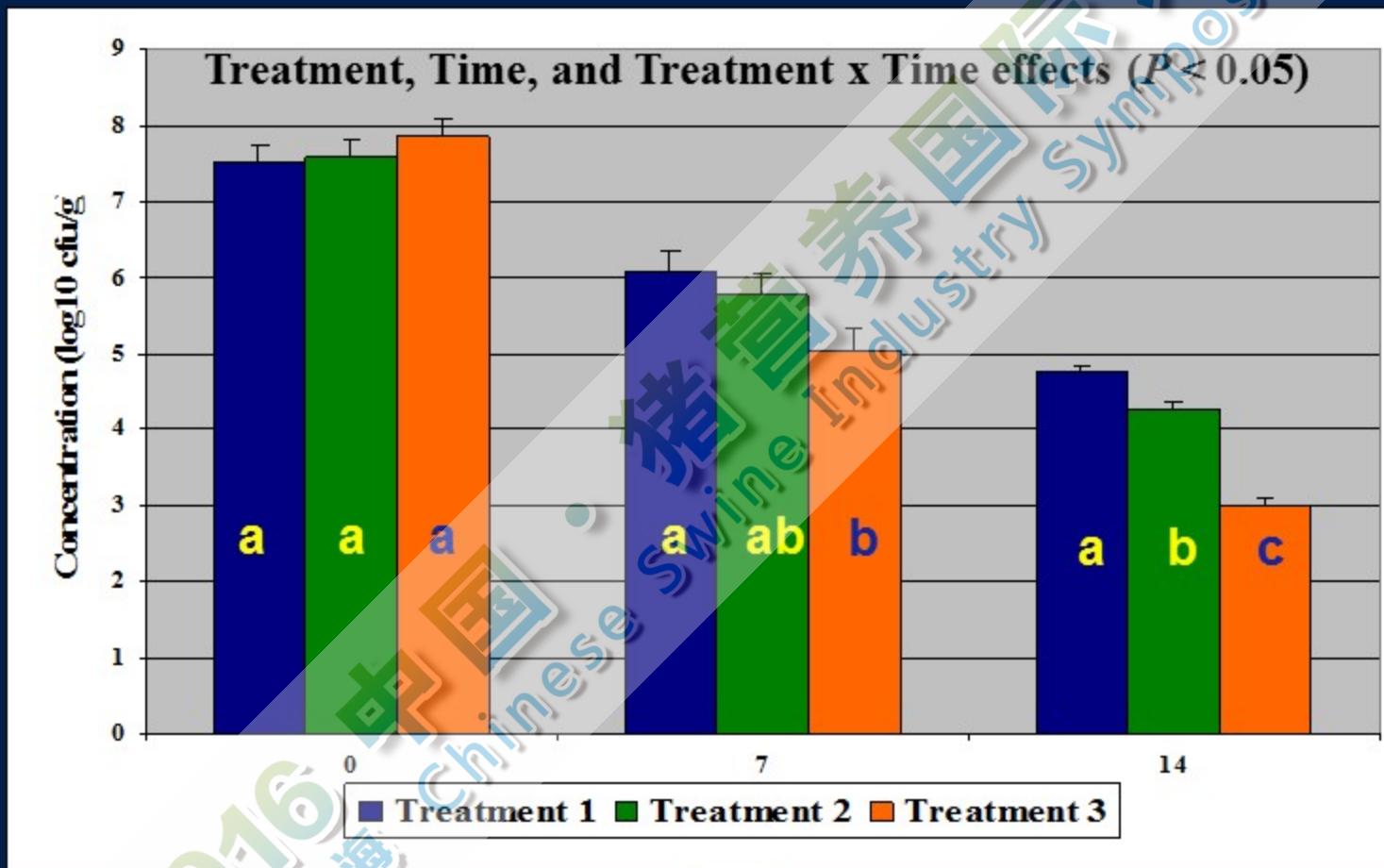
# *E. Coli*大腸杆菌



Mateo et al., 2005b



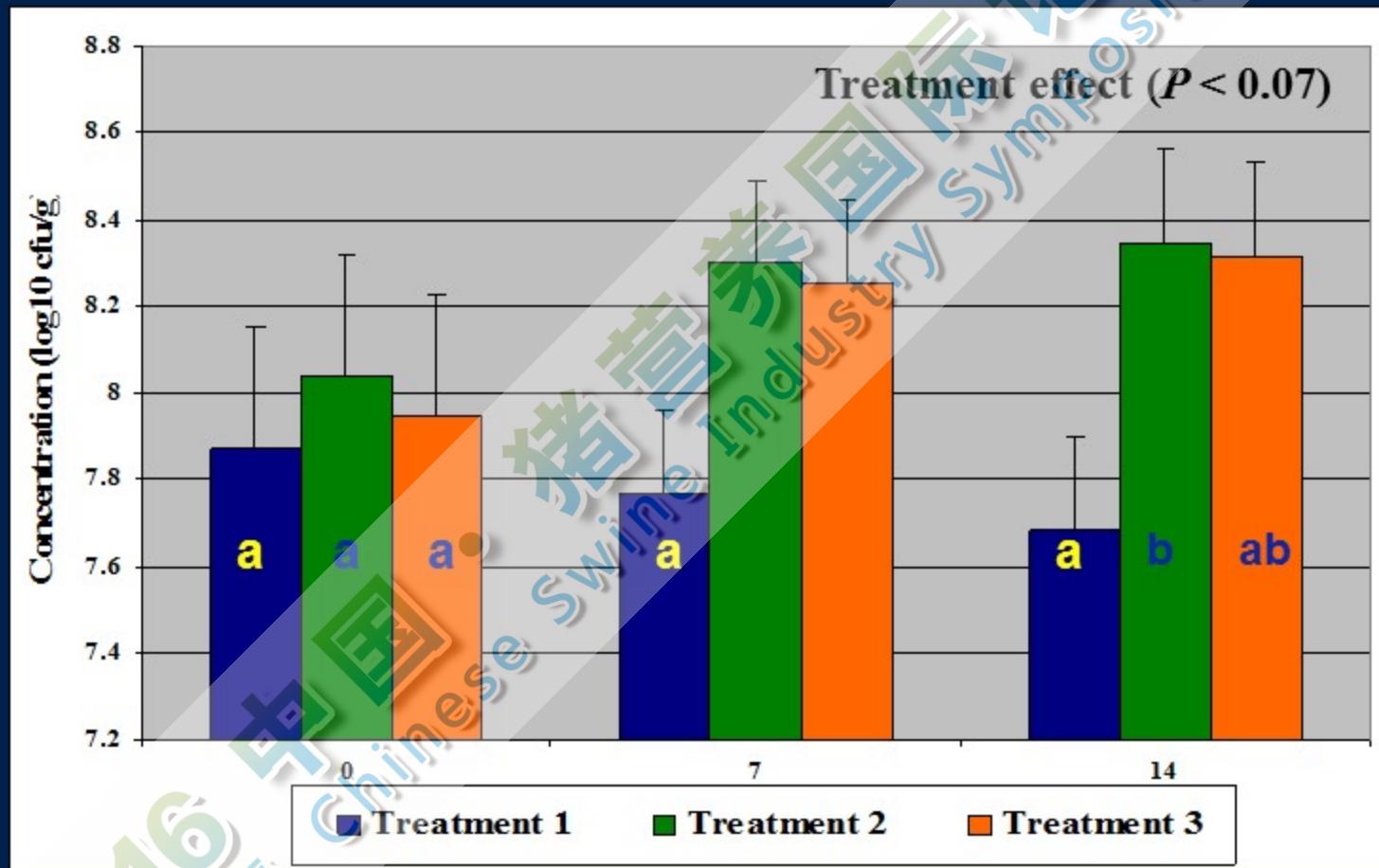
# *Clostridium Perfringens* 产气荚膜梭菌



Mateo et al., 2005b



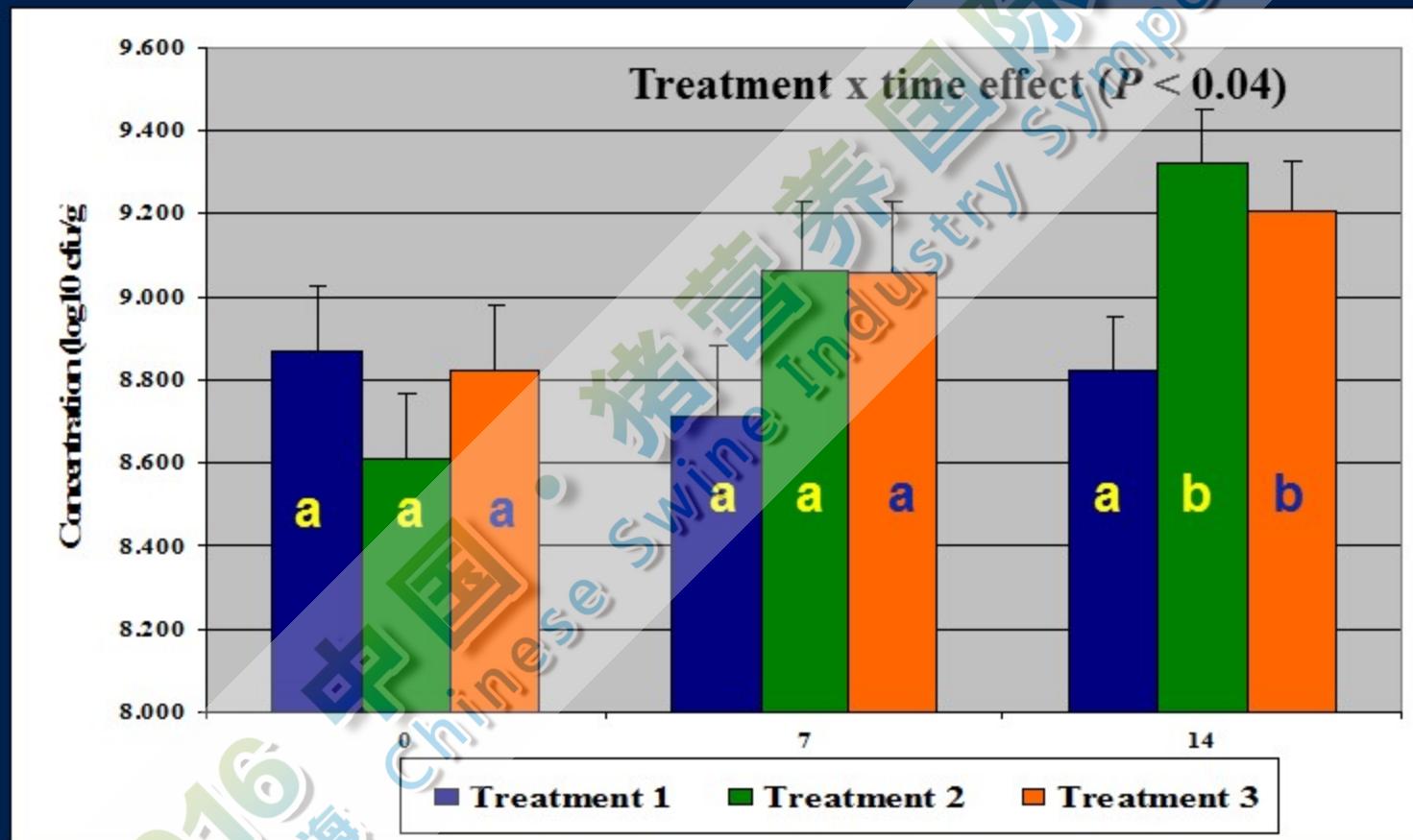
# *Bifidobacterium spp.* 双歧杆菌



Mateo et al., 2005b



# *L. Acidophilus*嗜酸乳杆菌



Mateo et al., 2005b



# Conclusions on Nucleotides 核苷酸小结



Young pigs may have  
nucleotide deficiency  
仔猪可能缺乏核苷酸



Possible modulation of  
Microbiota 可能调节菌群



Challenge supplying and  
analyzing nucleotides 核  
苷酸的提供和分析是挑战

Need for  
more  
research  
需要进一  
步研究

# Plant Extracts 植物提取物



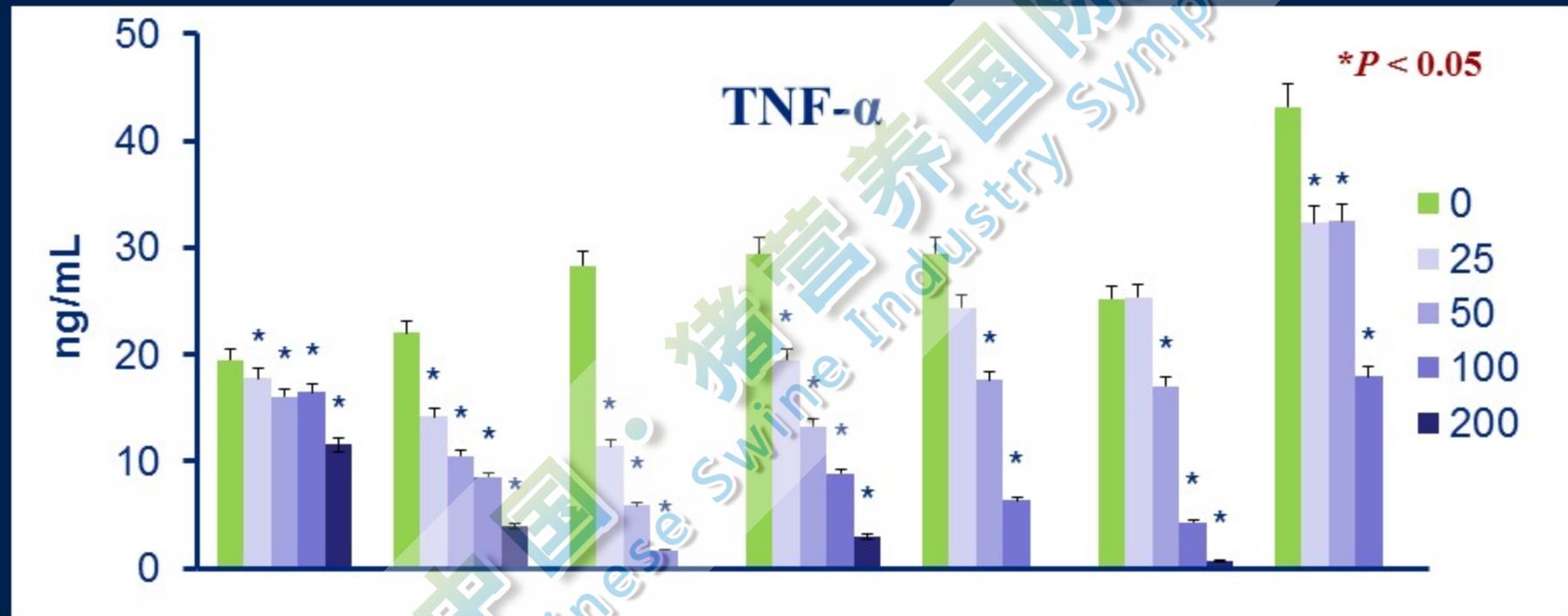
# Plant Extracts



- 1 Concentrated, hydrophobic, volatile aroma 浓缩、疏水、挥发性香气
- 2 Mixtures of secondary plant metabolites 植物次级代谢产物的混合物
- 3 Antimicrobial and Anti-inflammatory 抗菌和抗发炎
- 4 Antiviral, Antifungal, Antiparasitic, Antitoxicogenic 抗病毒、防霉菌、抗寄生虫、抗毒素

# In vitro anti-inflammatory effects

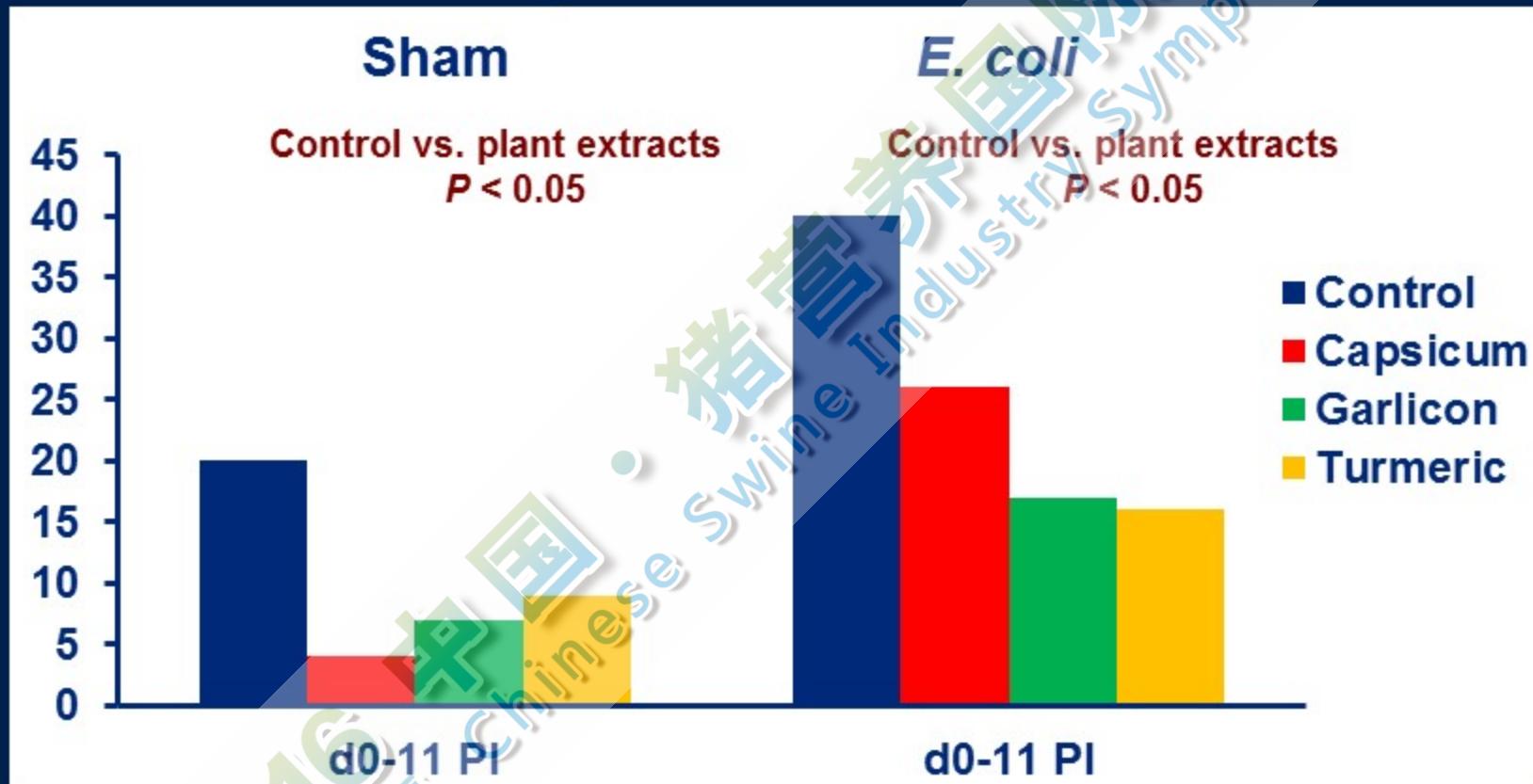
## 体外抗炎症效果

Anethol  
茴香醚Capsicum  
辣椒油Carvacrol  
香芹酚Eugenol  
丁香油酚Garlic  
大蒜素Cinnamal-  
dehyde肉桂醛Turmeric  
姜黄

Liu et al., 2012



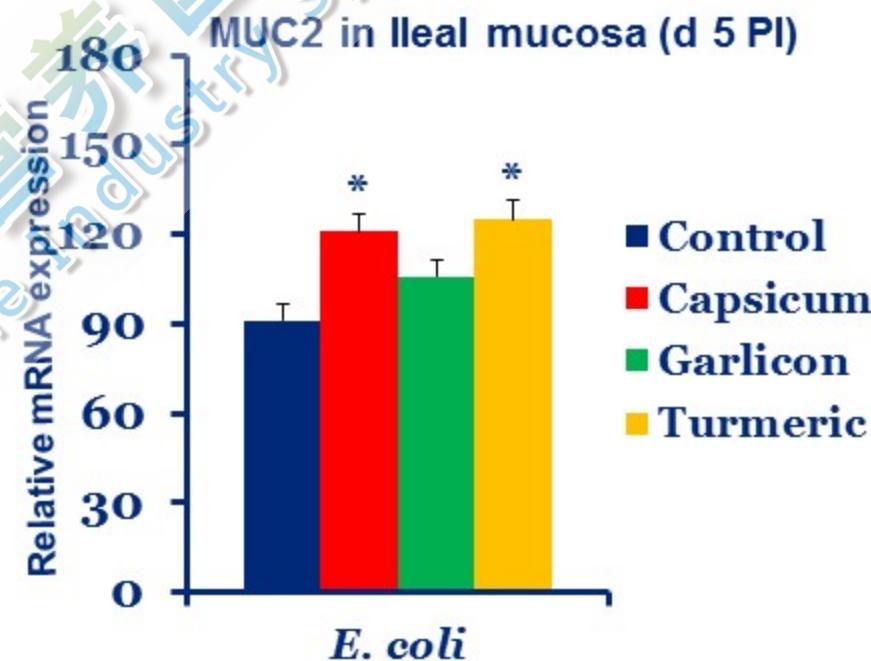
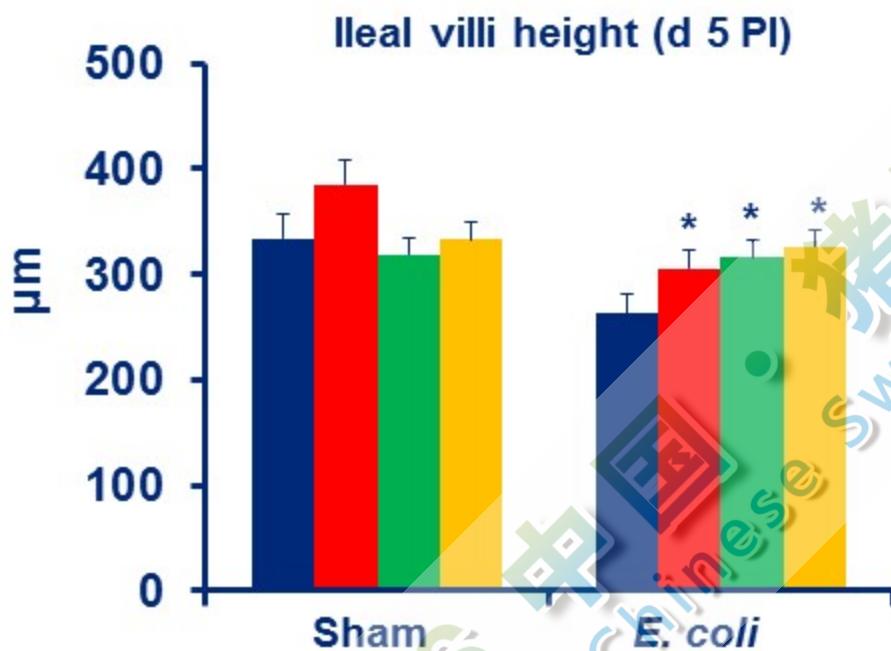
# In vivo Experiment, Diarrhea frequency 动物试验, 腹泻频率



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# Improved Gut Health 改善肠道健康

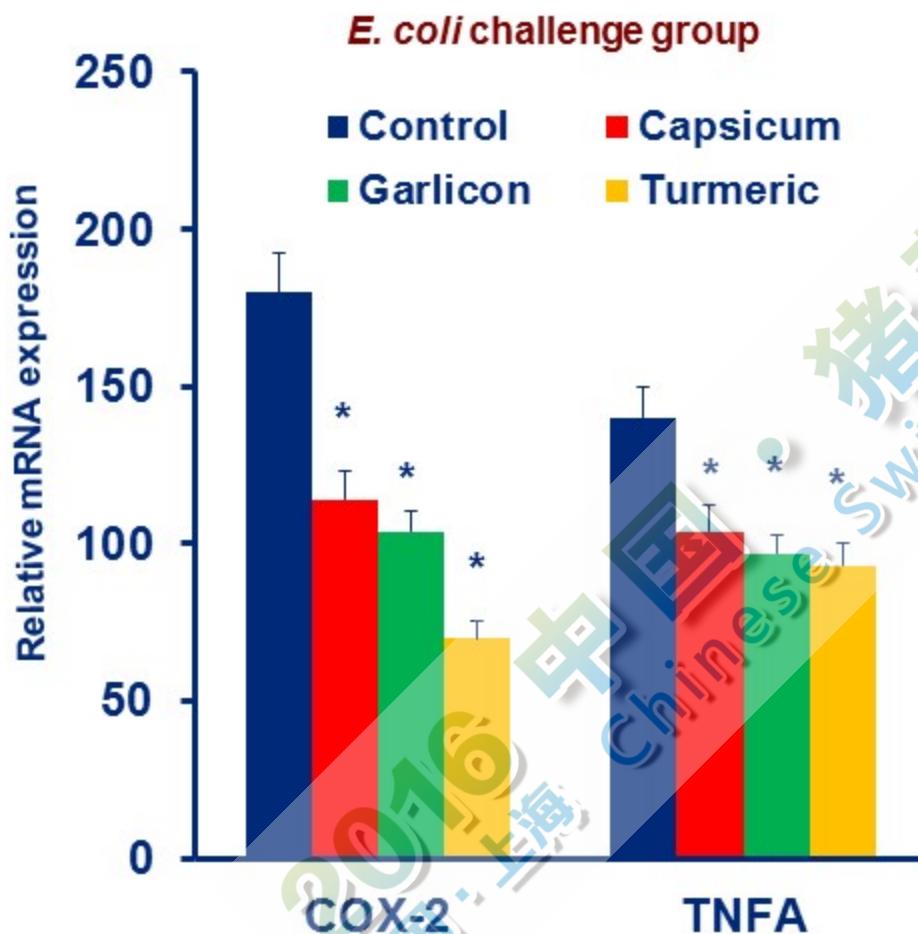


Possibly improved gut barrier function!  
可能是通过改善肠道屏障功能

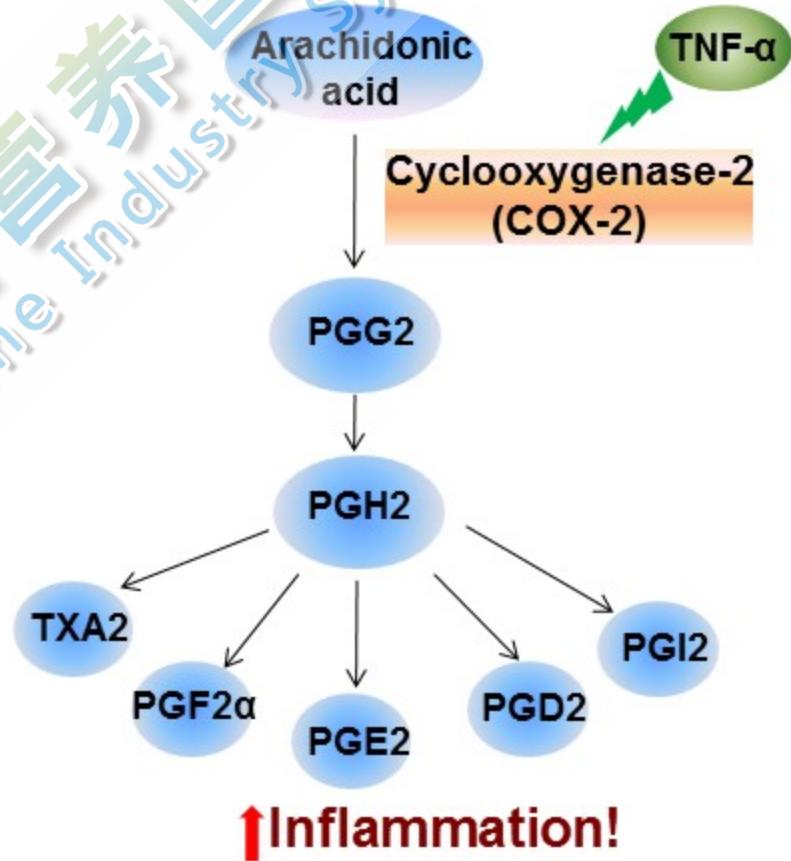
\* $P < 0.05$  compared with control

# Plant extracts reduced gut inflammation caused by *E. coli* infection

减少由大肠杆菌感染引起的肠道炎症



The Prostaglandin Pathway  
前列腺素通路



Reduced diarrhea and improved  
intestinal barrier function减少腹泻  
，改善肠道屏障功能

Reduced TNF- $\alpha$  and white  
blood cells and intestinal  
inflammation

降低TNF- $\alpha$ 和白细胞、肠道炎症

Need to have results verified in  
commercial experiments需要商  
业试验验证效果

# Plant Extracts 植物 提取物



# Overall Conclusions 总结

1

Many additives available

可用添加剂很多

2

Documented effects in controlled studies 在实验室条件下效果不错



Need testing under commercial conditions 需要在商业条件下测试

# Evaluation

1

Copper and Zinc have consistent effects  
铜和锌效果稳定

2

Acidifiers and plant extracts have many positive data  
酸化剂和植物提取物有很多正面试验数据

3

Prebiotics, probiotics, yeast, and nucleotides may work  
益生元、益生菌、酵母和核苷酸可能有效果



# Use Additive 使用添加剂

Economic value

> cost?

效益>成本?

Independent documentation?  
独立的研究结果?

Repeatable results on commercial farms?  
在商业条件下可重复?



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# Acknowledgement 致谢



<http://nutrition.ansci.illinois.edu>

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