IMPORTANCE OF LACTOSE IN PIGLET NUTRITION

乳糖在仔猪营养中的重要性

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Outline 提纲

I. Background 背景介绍

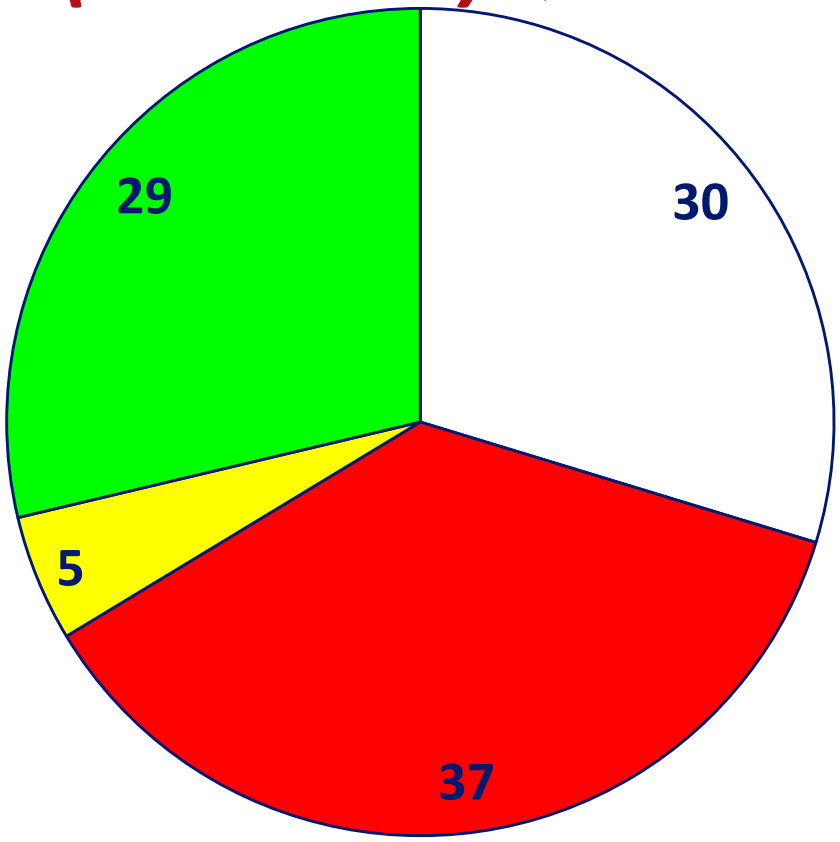
II. Lactose requirements 乳糖需求

III. Lactose is a unique sugar 乳糖是一种特殊的糖

IV. Impact on gut integrity & microbial populations
乳糖对肠道完整性和微生物菌群的影响

I. Conclusions 结论

Typical Sow Milk Composition
猪乳组成
(DM basis)（基于干物质）



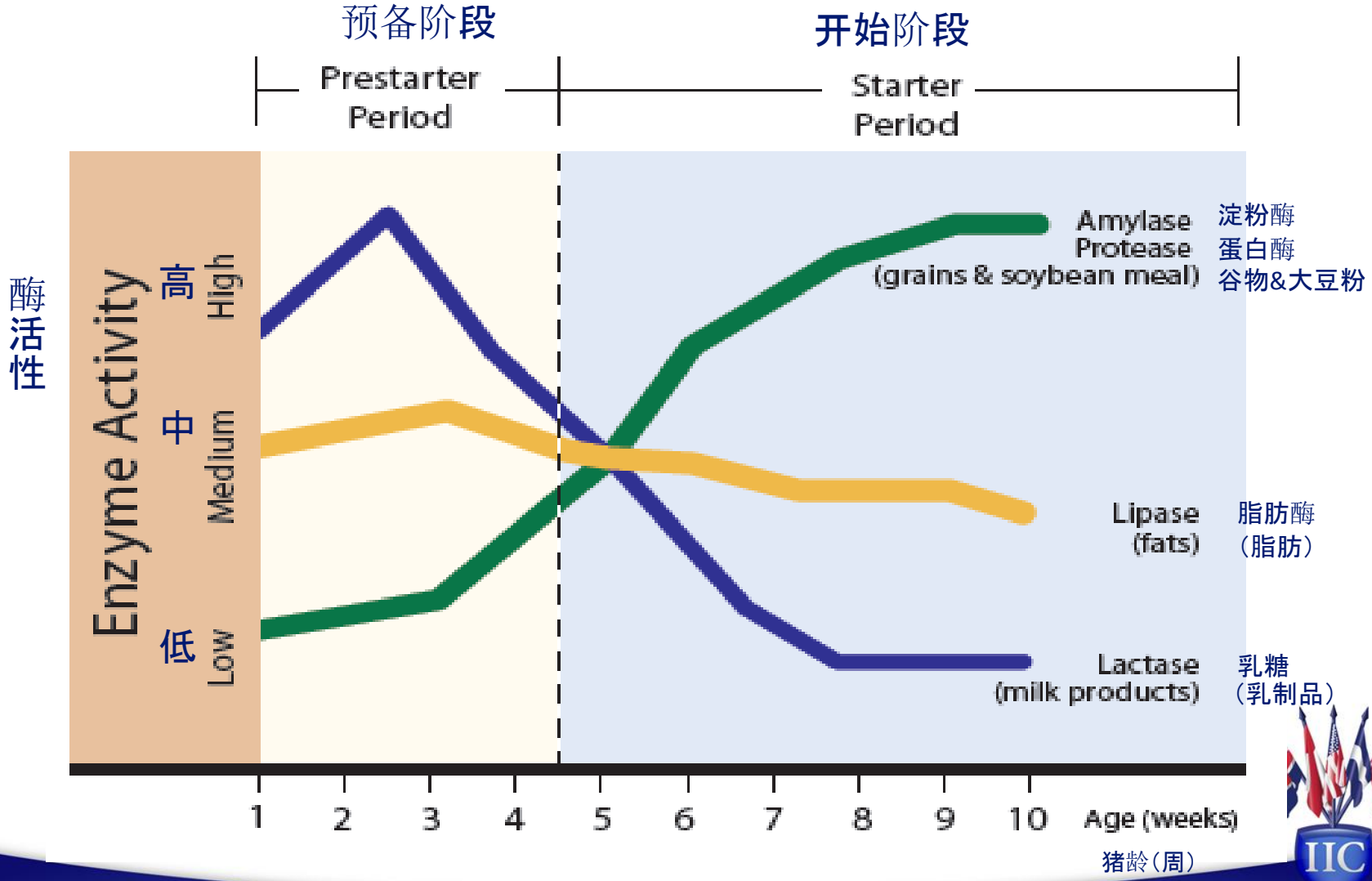
(Harrell & Odle, 2003)

Background 背景

- **Intensified pork production systems**
  集约化猪肉生产系统
  - Pigs weaned at an early age (~18 to 25 days)
    仔猪早期断奶(~18-25天)
  - Environmental stress, pathogen exposure, abrupt diet change
    环境应激，病菌接触，突然改变饲粮

- **Complex diets to minimize stress with weaning**
  应用复杂日粮以使断奶的应激减到最低
  - Highly digestible nutrients (match enzyme development)
    高度易消化的营养成分(匹配酶的发展)
  - Transition intestinal microflora
    安全过渡肠道菌群
  - Improve immune response
    改善免疫应答

Enzyme Development in Young Pigs
小猪体内酶的活性



Nursery Diets保育猪日粮

	Early Prestarter	Prestarter	Late Prestarter	Starter
Pig Weight 猪体重范围	7-10 lb	10-13 lb	13-18 lb	18-25 lb
Plasma 血浆	7 – 8%	3.5 – 5%	0 – 2%	0
Blood cells 红细胞	1 – 2%	2%	2%	0-1%
Select fish 优质鱼粉	3 – 8%	3 – 8%	3 – 5%	2-3%
Soy protein 大豆蛋白	13% max	18 % max	25% max	30% max
Lactose level 乳糖水平	**20 - 30 %**	**18 - 23%**	**7 - 12%**	**3 – 5%**
Lysine level 赖氨酸水平	1.6 – 1.7%	1.5 – 1.6%	1.4%	1.35%
Added zinc 锌添加量	3000 ppm	3000 ppm	2000-3000	2000-3000
Added Copper 铜添加量	250 ppm	250 ppm	125 ppm	125 ppm

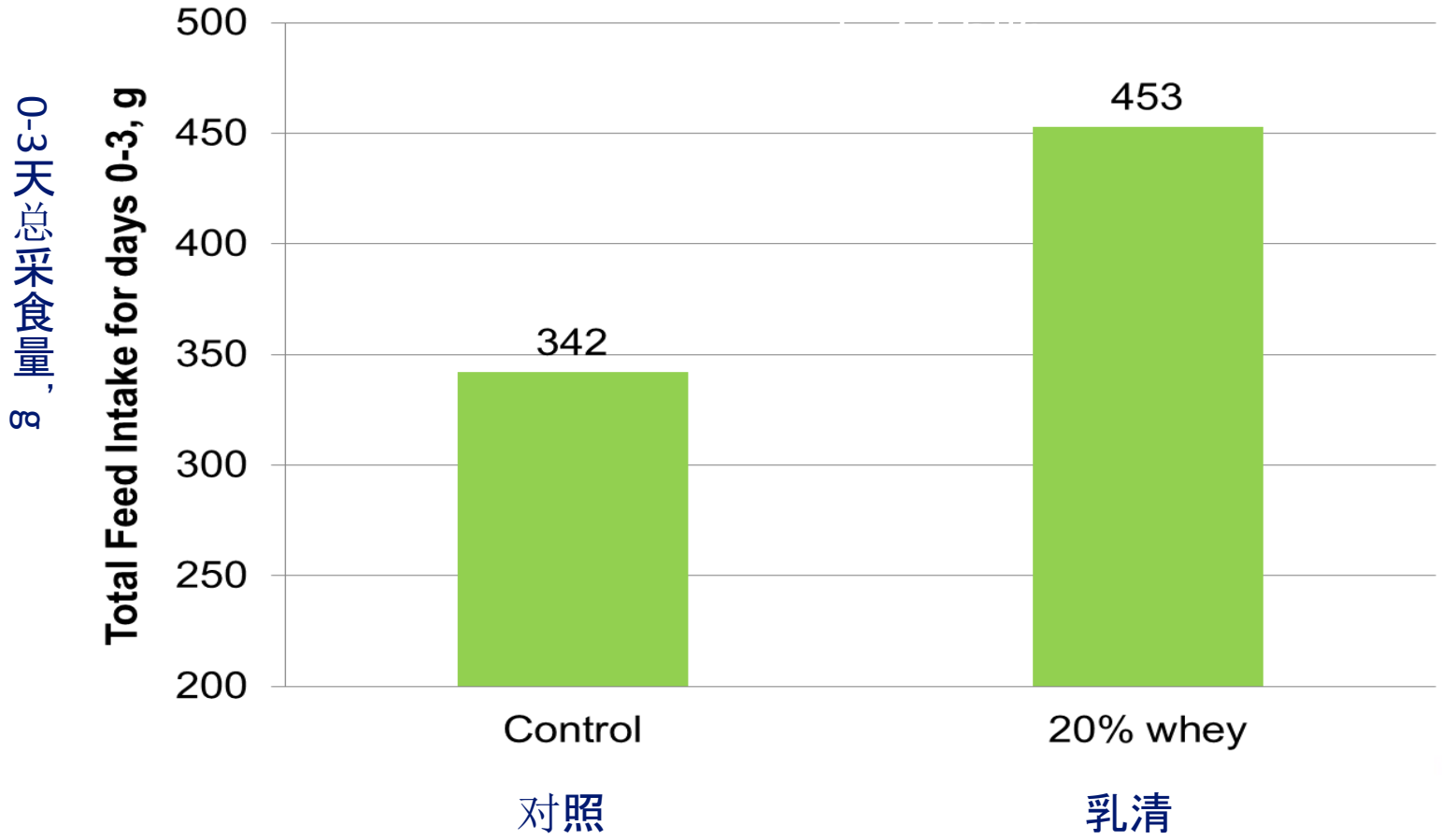
Wean/Finish Starters
断奶/育成 开食料

	Prestarter	Late Prestarter	Starter
Pig Weight 猪体重范围	10-12 lb	12-15 lb	15-25 lb
Plasma 血浆	4 – 5%	3 – 5%	0
Blood cells 红细胞	2%	2%	1-2%
Select fish 优质鱼粉	3 – 8%	3 – 8%	3 - 6%
Soy protein 大豆蛋白	16% max	20% max	30% max
Lactose level 乳糖水平	**18 - 23%**	**12 - 18%**	**6 – 9%**
Lysine level 赖氨酸水平	1.5 – 1.6%	1.5 – 1.6%	1.40%
Added zinc 锌添加量	3000 ppm	3000	2000-3000
Added Copper 铜添加量	250 ppm	125 ppm	125 ppm

Importance of lactose in pig starter diets
乳糖在仔猪开食料中的重要性

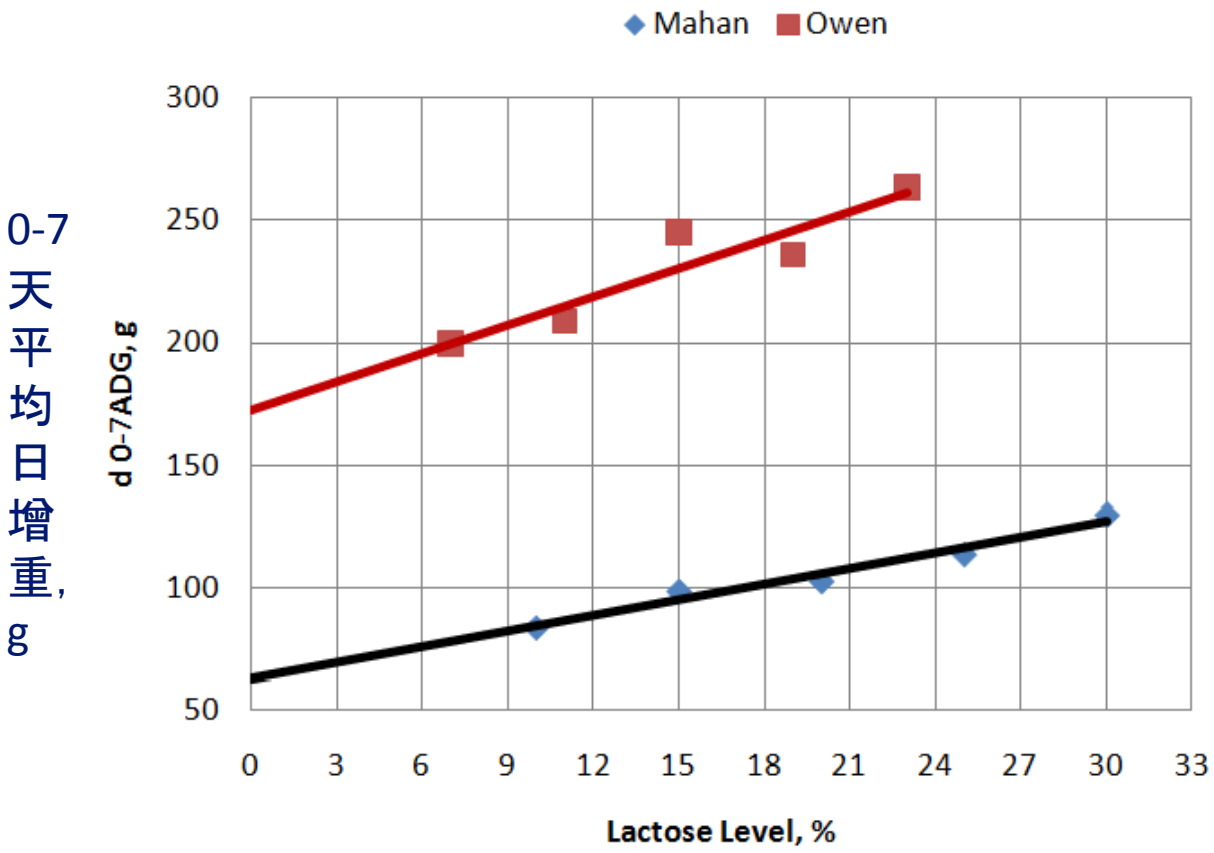
1. Readily available energy source. 非常容易消化的能源
2. Enhances feed intake and digestion of nutrients. 增加采食量和营养消化率
3. Conversion of lactose to lactic acid in the gut. 乳糖在肠道内转化为乳酸
4. Influences intestinal microflora populations. 影响肠道菌群
5. Increases Ca absorption in small intestine. 增加肠道内钙的吸收
6. Acidification increases protein digestion. 酸化剂增加蛋白质的消化率
7. Enhances integrity of intestinal villi and nutrient absorption. 增强肠道绒毛的完整性和对营养的吸收

Effect of Lactose on Total Feed Intake d 0-3 Post-Weaning
乳糖对断奶后0-3天仔猪总采食量的影响



Southern et al. 2009

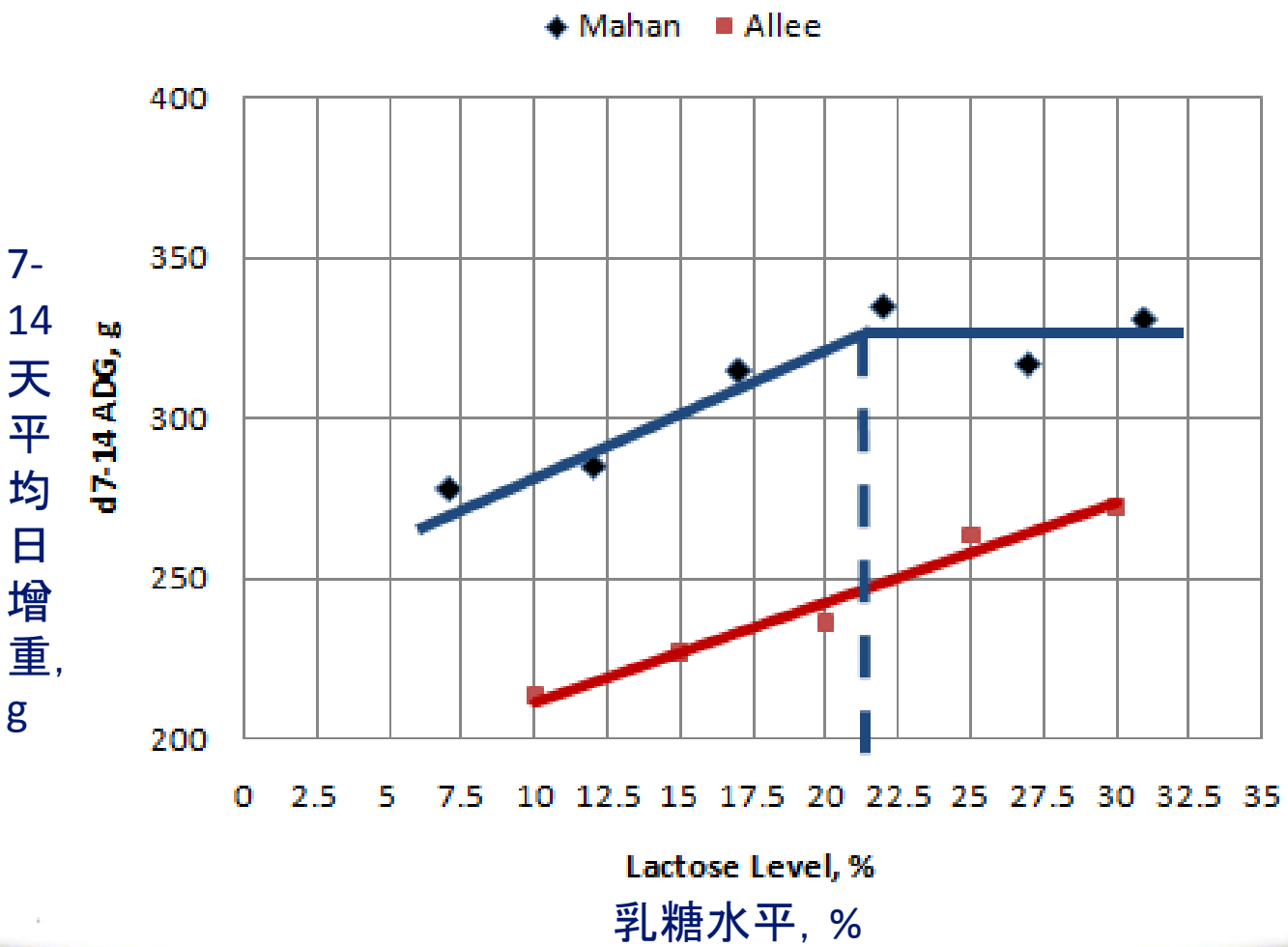
Effect of Lactose on d 0-7 ADG
乳糖对0-7天平均日增重的影响



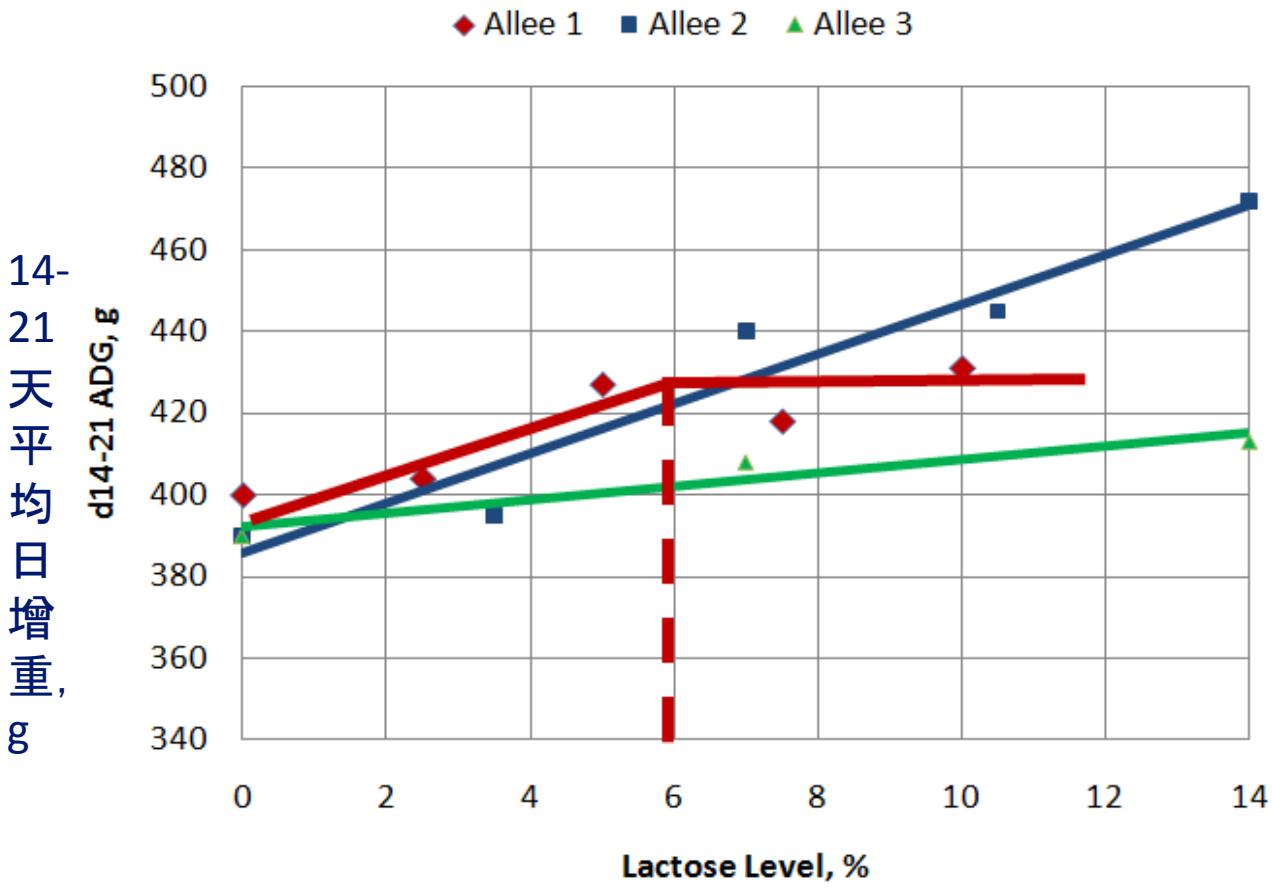
0-7天平均日增重，g

乳糖水平，%

Effect of Lactose on d 7-14 ADG
乳糖对7-14天平均日增重的影响



Effect of Lactose on d 14-21 ADG
乳糖对14-21天平均日增重的影响



14-21天平均日增重，g

乳糖水平，%

Recommended Levels of Lactose in Swine Starter Feeds
在保育料中乳糖推荐水平

- Day 0-7 20%
- Day 7-14 15%
- Day 14-21 7.5%

Lactose Recommendations
PIC and National Swine Nutrition Guide (NSNG)
PIC乳糖推荐量和全国猪营养指南

12 lb pig 猪体重12磅	PIC	NSNG 全国猪营养指南
Phase 1 Budget, lb feed 第一阶段，饲料添加量，磅	1	1
Phase 1 Pig Wt. 第一阶段，猪体重	12-12.75	12-12.75
Phase 1 Lactose % 第一阶段，乳糖水平，%	20	23
lbs of Lactose in Phase 1 第一阶段，乳糖添加量	0.20	0.23
Phase 2 Budget, lb feed 第二阶段，饲料添加量，磅	4	3
Phase 2 Pig Wt. 第二阶段，猪体重	12.75-15.95	12.75-15.15
Phase 2 Lactose % 第二阶段，乳糖水平	15	18
lbs of Lactose in Phase 2 第二阶段，乳糖添加量	0.60	0.54
Phase 3 Budget, lb feed 第三阶段，饲料添加量	12	13.75
Phase 3 Pig Wt. 第三阶段，猪体重	15.95-25	15.15-25
Phase 3 Lactose % 第三阶段，乳糖水平	7.5	7.2
lbs of Lactose in Phase 3 第三阶段，乳糖添加量	0.90	0.99
Total lbs of feed 饲料总添加量	17	17.75
Total lbs of lactose 乳糖总添加量	1.7	1.76

Lactose Consumption Recommendation
乳糖推荐消耗量

Required to reach 1.76 lb (0.80 kg) of total lactose consumption.
要求乳糖总消耗量达到1.76磅（0.8kg）

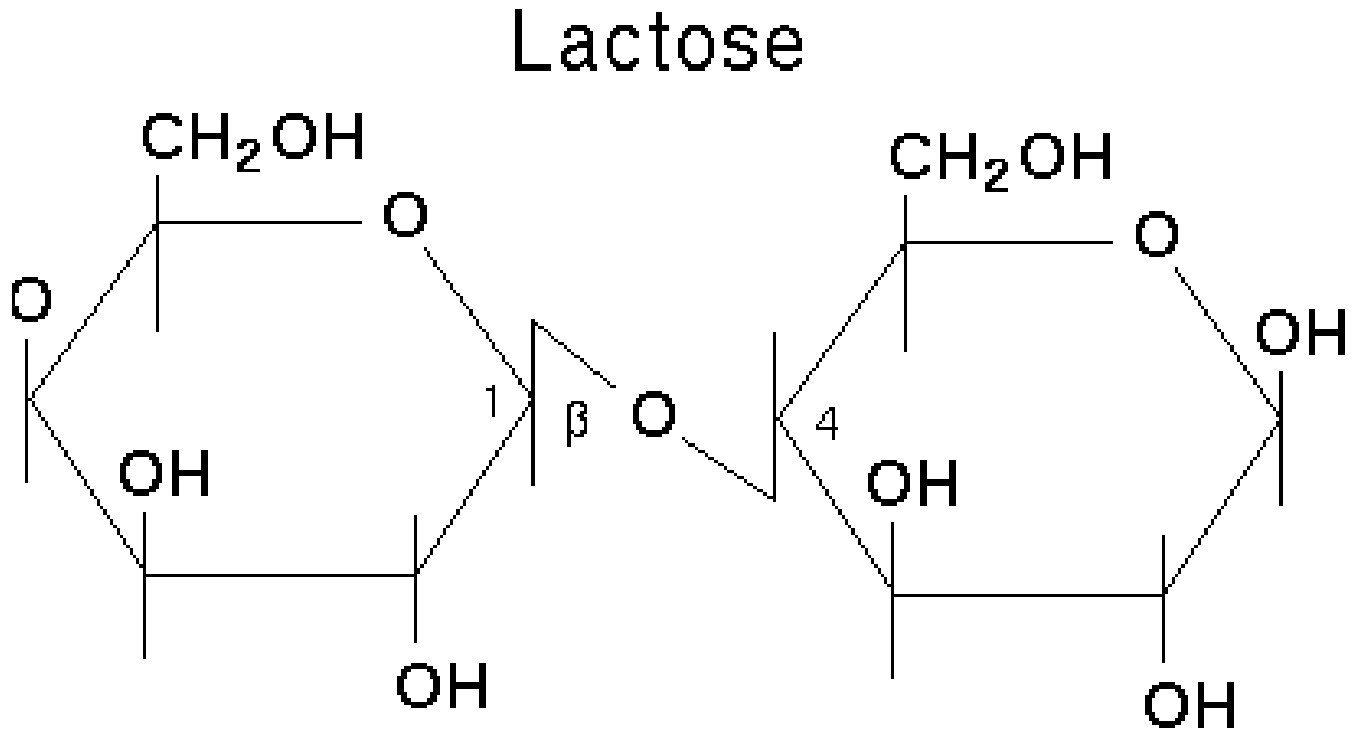
Lactose Source 乳糖来源	% Lactose 乳糖水平	Kg. per pig 每头猪，kg
Crystalline Lactose 结晶乳糖	95	0.84
Whey Permeate 乳清渗透物（低蛋白）	80	1.00
Sweet Whey 甜乳清（高蛋白）	70	1.14

Lactose is a Unique Sugar
乳糖是一种特殊的糖

1. Lactose cannot be totally replaced with other sugars (it is essential).
   乳糖无法被其他糖完全替代(属必需)
2. Lactose is a disaccharide of glucose and galactose that is only found in milk products. Why?
   乳糖属二糖，由葡糖糖和半乳糖组成，只存在于乳制品中，为什么？
3. Does lactose play a role other than supplying energy to the infant or young animal?
   乳糖除了向婴儿或幼小动物提供能量外，还有什么作用？

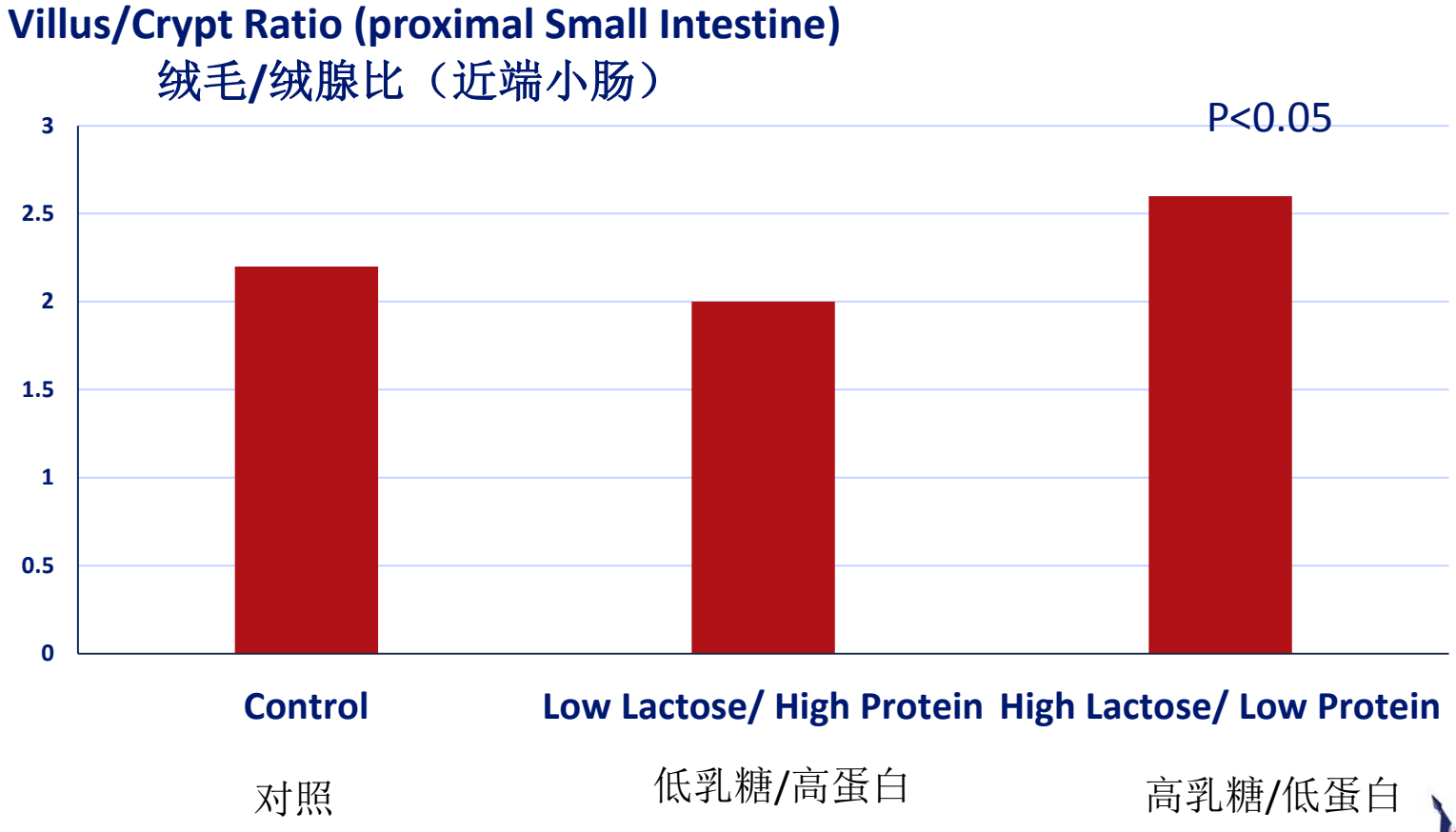
Lactose A two-ring sugar: glucose and galactose

乳糖:一种二环糖:葡糖糖和半乳糖



Effects of Lactose Level on Intestine Morphology of Piglets Fed Milk Replacers

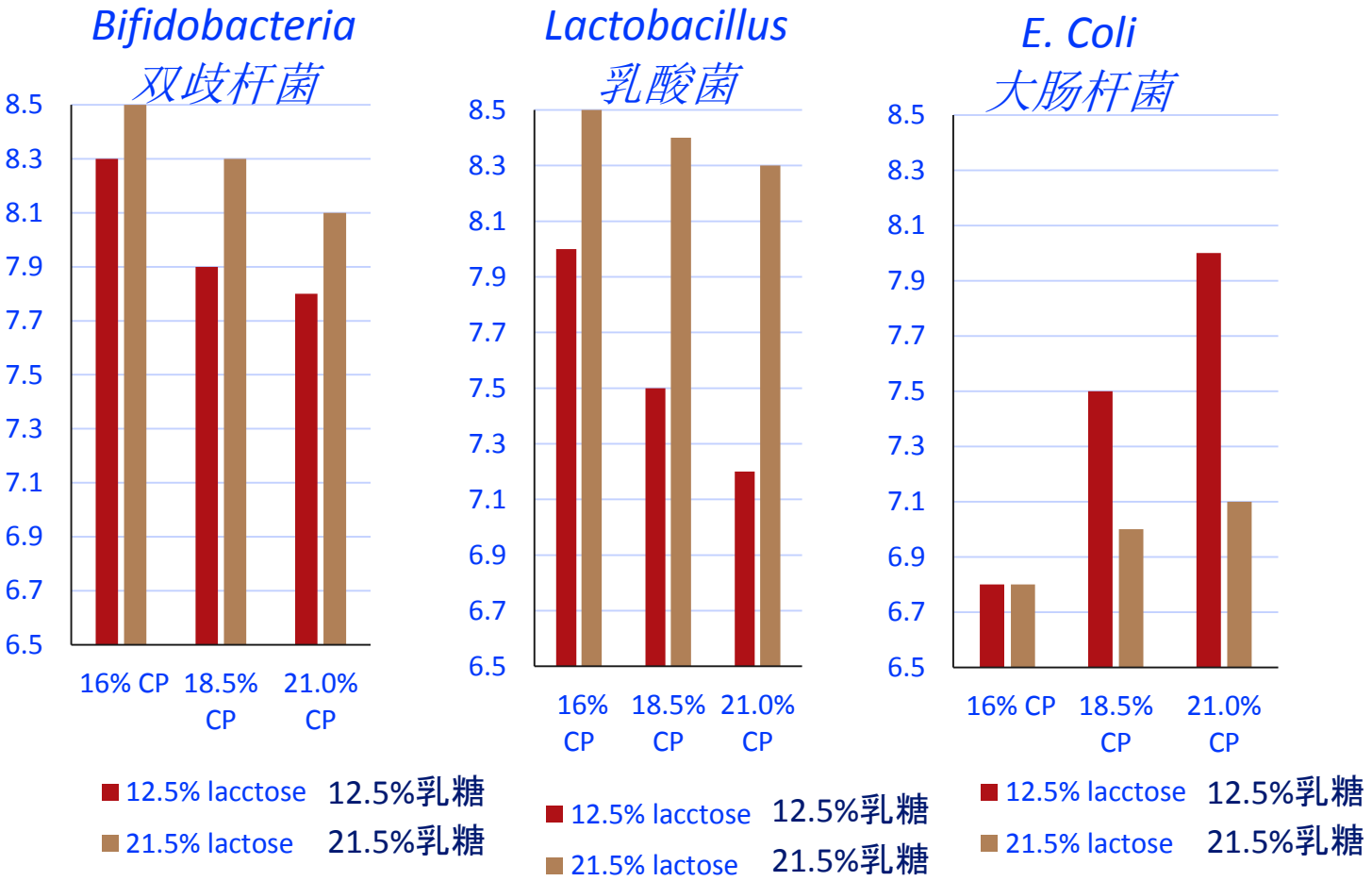
乳糖水平对饲喂代乳粉的仔猪肠道形态的影响



(M. A. M. Spreeuwenberg, et al., J. Nutrition 131:1520-1627, 2001)

The Effects of Lactose Level and CP on Fecal Microbial Populations in Weaned Pigs (log_{10} cfu/g)

乳糖水平和粗蛋白对断奶仔猪粪便微生物菌群的影响



K. M. Pierce and et al., Animal Feed Sci. and Tech. 132 (2007) 267-282

Conclusions 结论

1. Sows milk is 29% lactose (DM basis). Young piglets have high levels of intestinal lactase enzyme to readily digest lactose.
母猪奶中含有29%的乳糖（基于干物质），而仔猪有很高水平的肠乳糖酶，可以轻松消化乳糖。

2. Lactose requirements for optimal pig growth are 20%, 15%, and 7.5% for phase-1 (0-7 d postweaning), phase-2 (7-14 d), and phase-3 (14-21 d), respectively.
适合小猪生长的乳糖需求：第一阶段（断奶后0-7天）为20%；第二阶段（7-14天）为15%；第三阶段（14-21天）为7.5%。

3. For optimum performance, pigs should consume about 0.8 kg of lactose in its lifetime (1 kg of permeate).
达到最佳生产性能，一只猪需要消耗约0.8kg的乳糖（1kg低蛋白乳清粉）。

Conclusions结论

4. Lactose is a unique sugar (disaccharide of glucose + galactose) only found in milk products.

   乳糖是一种特殊的糖(由葡萄糖和半乳糖结构的二糖)，仅存在于乳制品中。

5. Besides being a readily digestible energy source for the piglet, lactose enhances gut integrity and has beneficial effects on gut microflora populations.

   除了作为一种容易消化的体内能量来源，乳糖还可以增强仔猪肠道的完整性，并有利于肠道微生物种群。

6. Lactose is an essential, critical nutrient for early weaning of piglets in today's intensive pig production systems.

   在现在集约化的猪生产系统中，乳糖对早期断奶仔猪来说是一种必需且非常重要的营养。

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