NUTRITIONAL VALUE OF MILK PROTEIN AND MILK FAT

乳蛋白和乳脂肪营养评估

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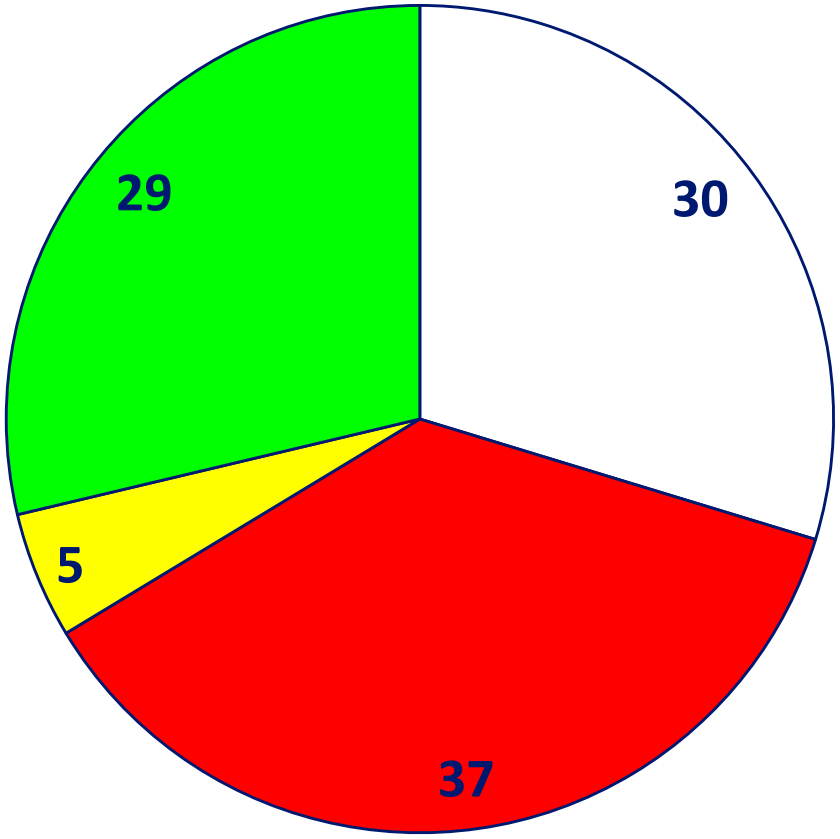
Outline
提纲

- Milk Protein乳蛋白
  - Amino acid balance 氨基酸平衡
  - Amino acid digestibility 氨基酸的可消化性
  - Casein and whey proteins 酪蛋白和乳清蛋白
  - Commercial sources of milk protein
    乳蛋白的商业来源

- Milk Fat乳脂肪
  - Fatty acid composition 脂肪酸组成
  - Performance benefits vs. other fats
    与其他脂肪相比之下的优势表现
- Conclusions 结论

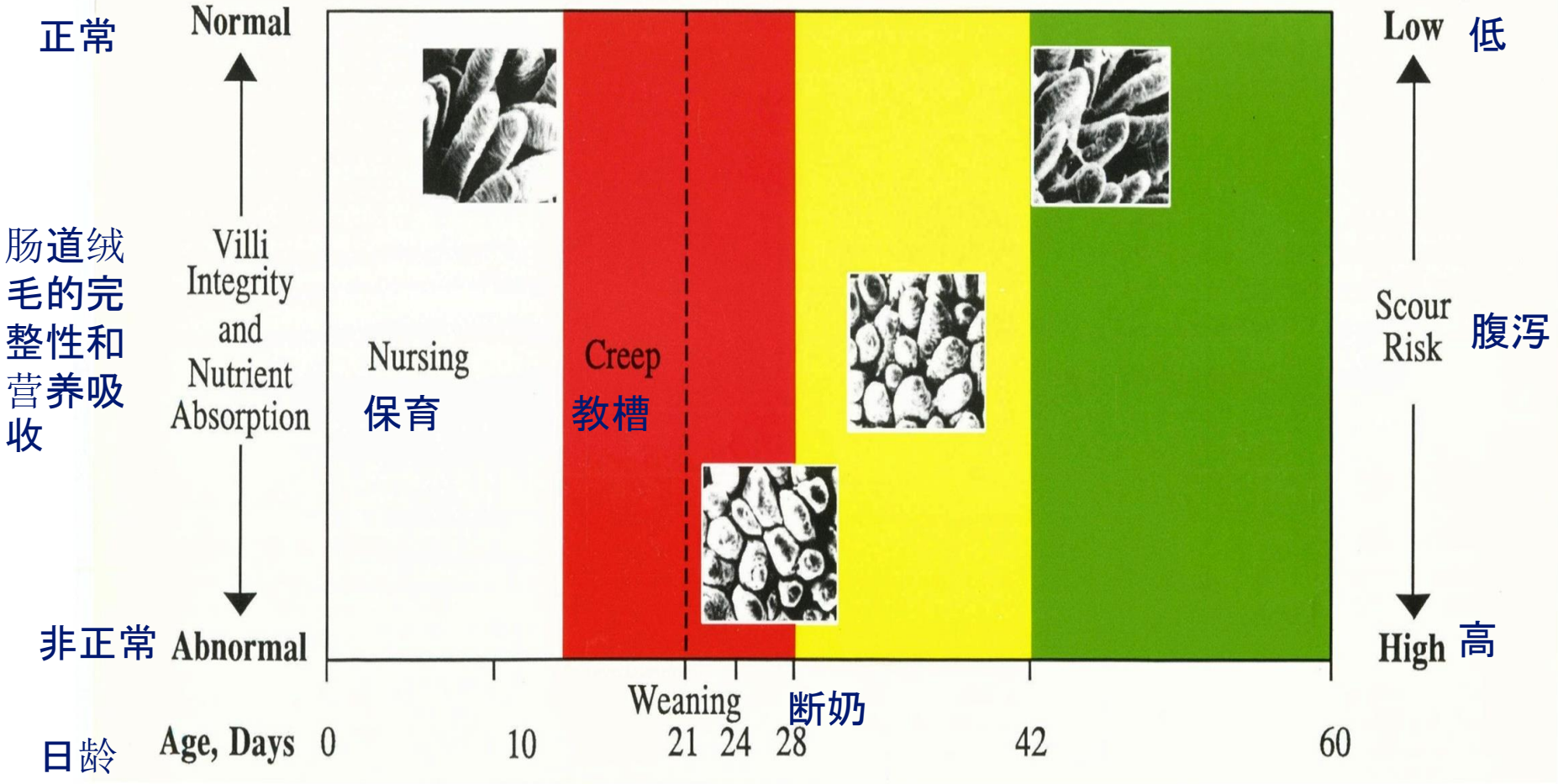
Typical Sow Milk Composition
典型猪乳组成
(DM basis)(基于干物质)



(Harrell & Odle, 2003)

Development of the Small Intestine in the Young Pig

仔猪小肠的发育



Milk Protein Characteristics

乳蛋白特性

- Milk protein sources have long been known to be excellent ingredients in diets for weanling pigs.

  乳蛋白是人们很早就知道的断奶猪料中的优异原料

- Characteristics of milk protein sources:

  乳蛋白源的特性

  - Palatable 适口性强
  - Highly digestible (proteins, fat, lactose, and minerals)

    高度易消化（蛋白、脂肪、乳糖和矿物质）
  - Superior amino acid profile

    优异的氨基酸结构
  - Bioactive proteins that benefit gut health

    生物活性蛋白有益于肠道健康
    - lactoferrin, lactoperoxidase, immunoglobulins

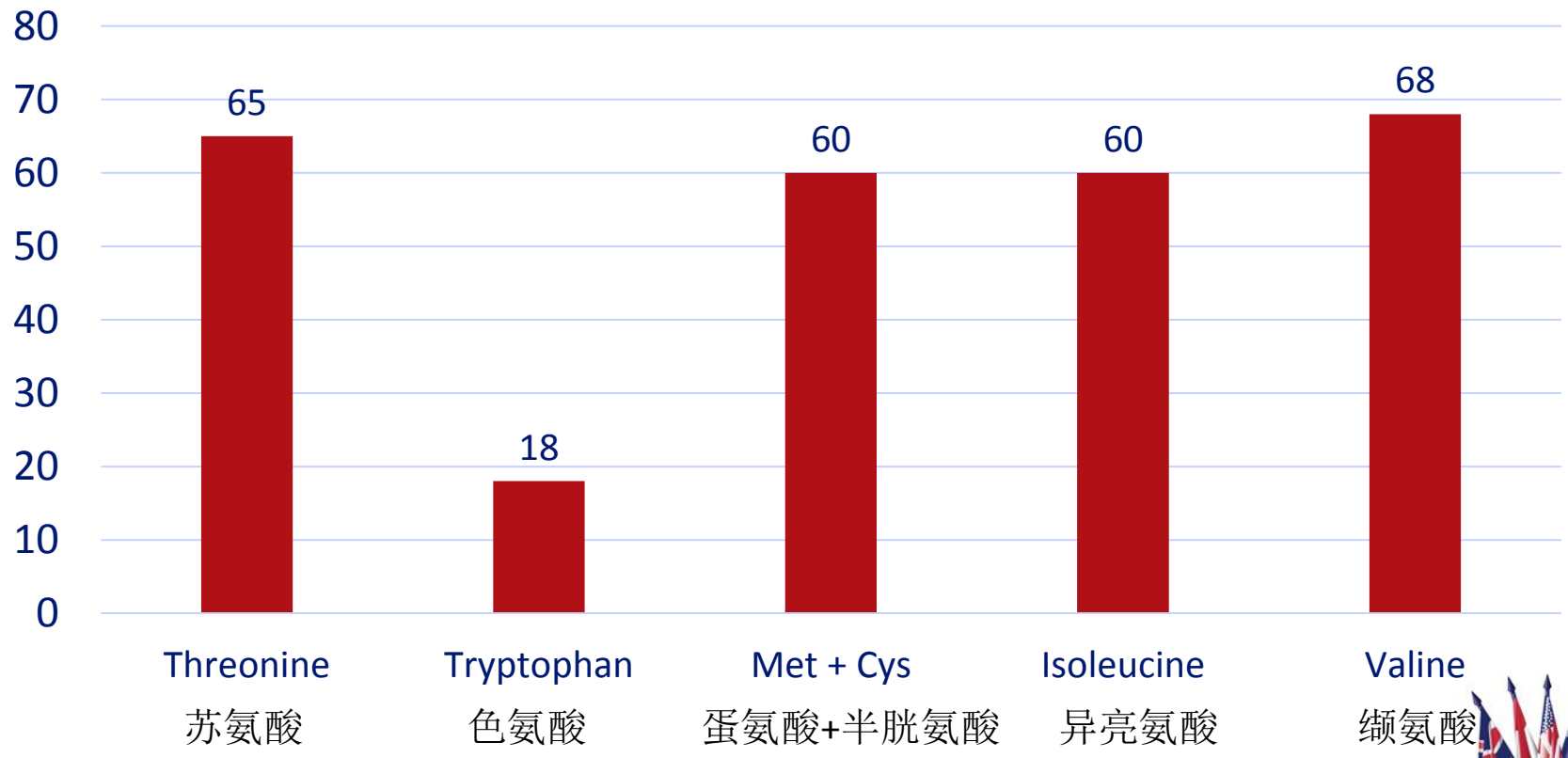
      乳铁蛋白，乳过氧化物酶，免疫球蛋白

(Cromwell, 2008)

Amino Acid Balance
氨基酸平衡

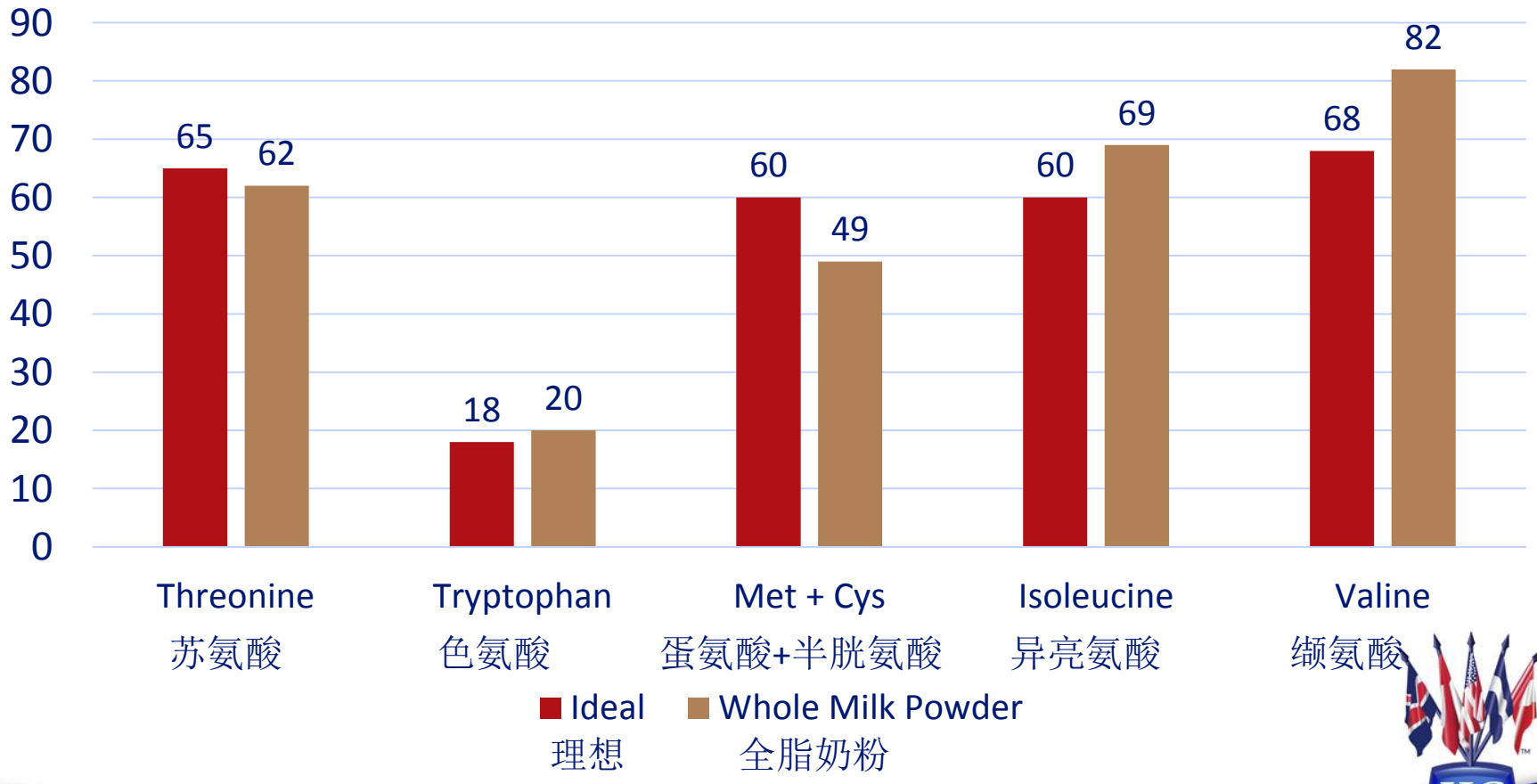
Ideal Pattern of Amino Acids for 5-20 kg Pig (% of lysine)

5-20kg仔猪氨基酸理想模型（相当于赖氨酸的百分比）

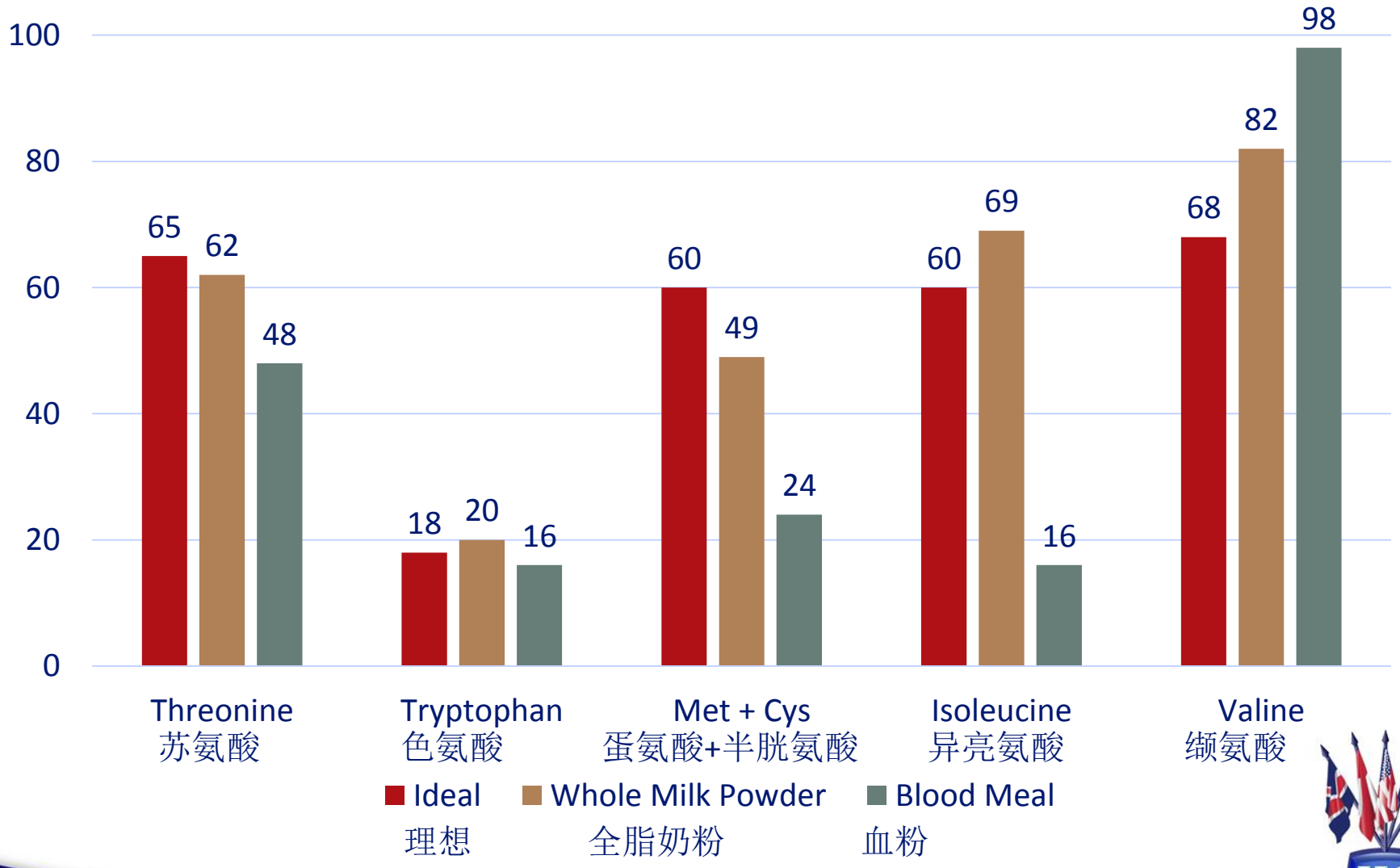


(Chung and Baker, 1992)

Amino Acid Pattern
Ideal vs. Whole Milk Powder
氨基酸理想模型和全脂奶粉比较



Amino Acid Patterns (% of lysine)
氨基酸模型(相当于赖氨酸的百分比)



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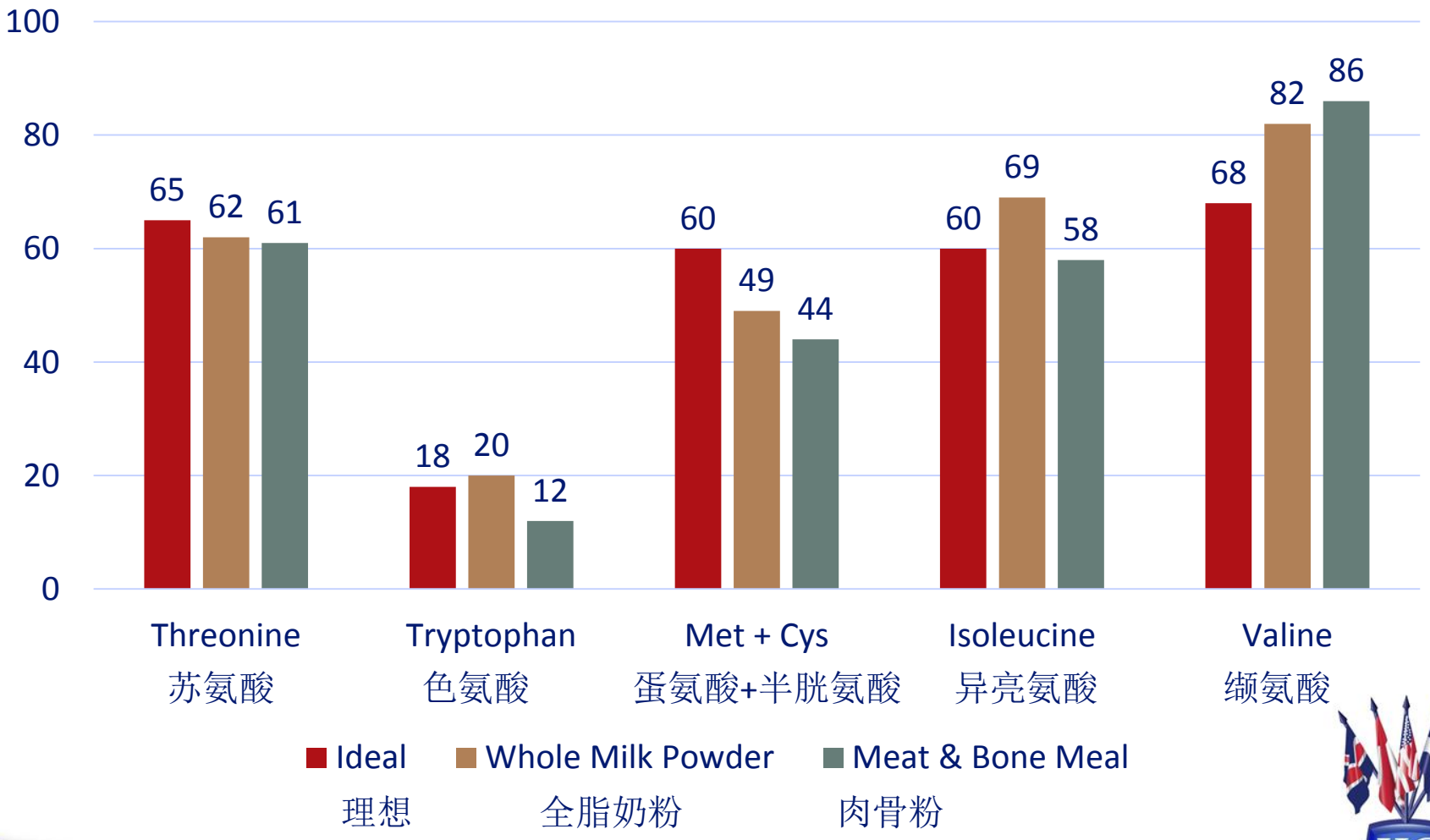

Amino Acid Patterns (% of lysine)
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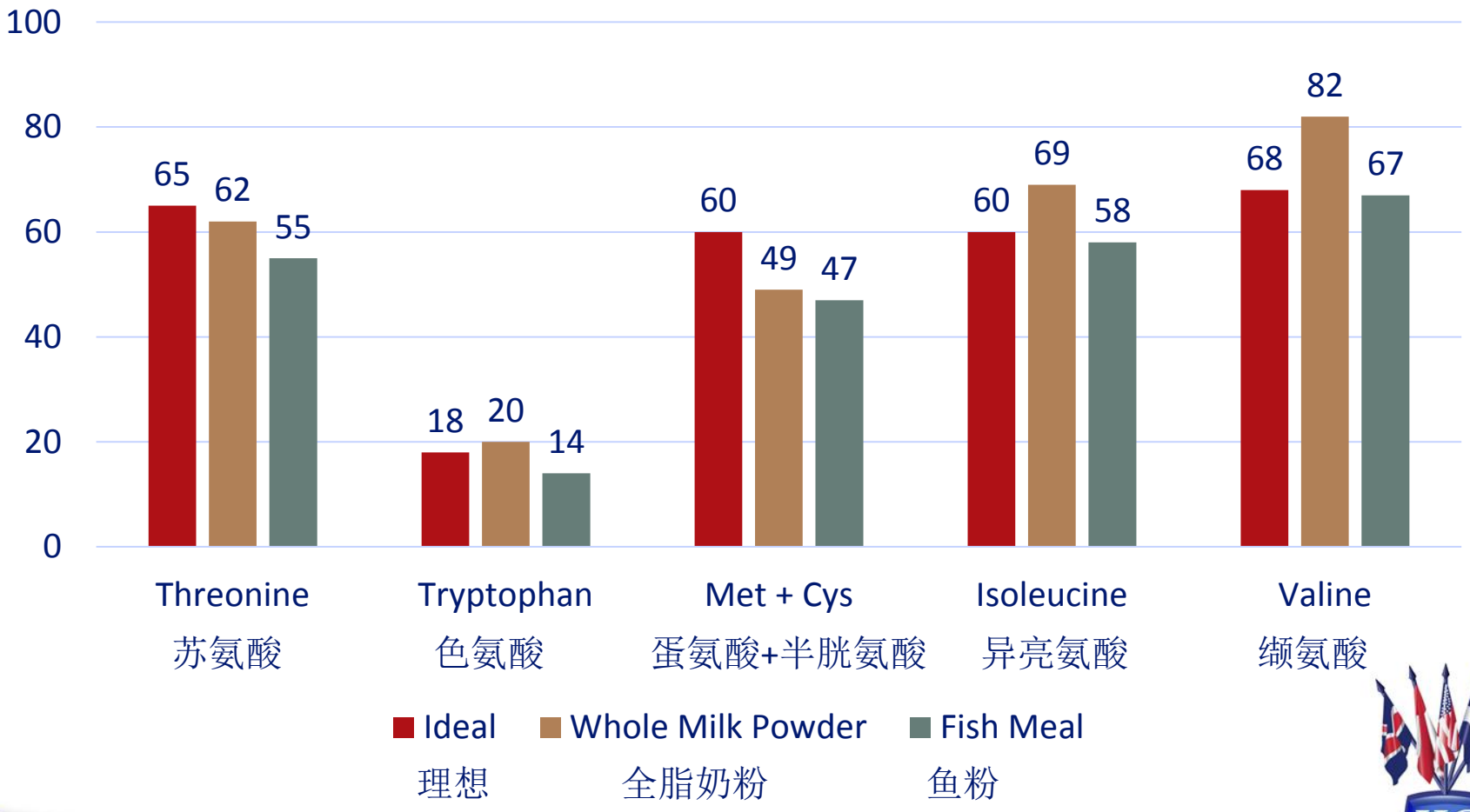


Amino Acid Digestibility
氨基酸消化性能

Whole Milk Powder
Ileal Standardized Digestibility, %
全奶粉回肠标准消化率, %

Crude protein 粗蛋白	Lysine 赖氨酸	Threonine 苏氨酸	Met + Cys 蛋氨酸+半胱氨酸	Tryptophan 色氨酸
90	89	94	96	97

Isoleucine 异亮氨酸	Valine 缬氨酸	Leucine 亮氨酸	Phe + Tyr 苯丙氨酸+酪氨酸	Histidine 组氨酸
89	92	97	98	97

(AmiPig, Ajinomoto Eurolysine, Aventis, INRA, ITCF, 2000)

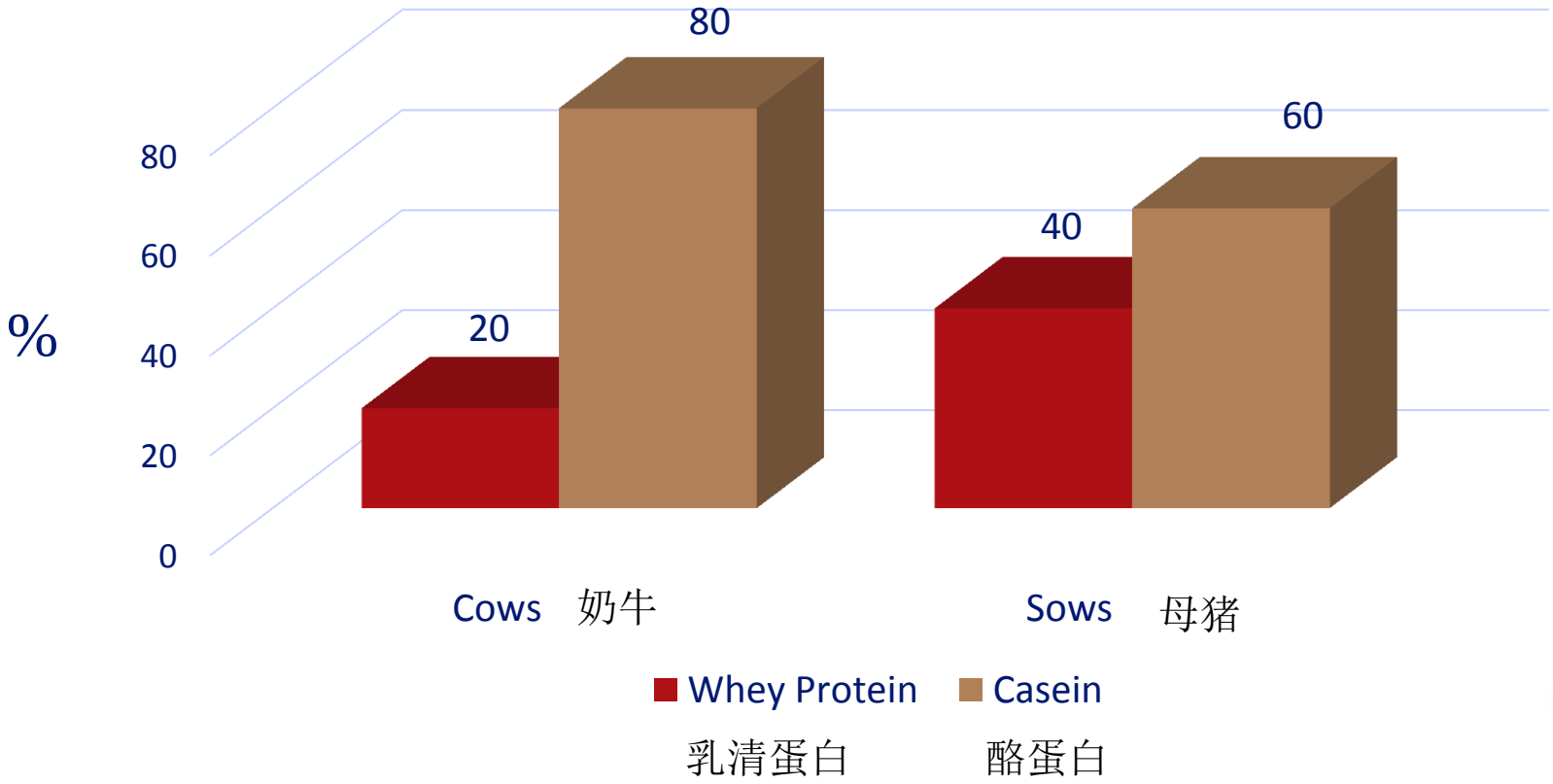
Ileal Standardized Digestibility
Whole Milk Powder vs. Other Animal Proteins
回肠标准消化率 全奶粉对比其它的动物蛋白

	C.P. 粗蛋白	LYS 赖氨酸	THR 苏氨酸	MET + CYS 蛋氨酸+半胱氨酸	TRP 色氨酸
Whole Milk Powder 全脂奶粉	90	89	94	96	97
Blood Meal 血粉	82	86	85	82	88
Meat & Bone Meal 肉骨粉	81	84	82	79	80
Poultry Meal 禽肉粉	76	77	76	73	69
Fish Meal 鱼粉	89	93	92	91	89

(AmiPig, Ajinomoto Eurolysine, Aventis, INRA, ITCF, 2000)

Casein and Whey Proteins
酪蛋白和乳清蛋白

Comparison of Milk Protein Composition of Cows and Sows
奶牛和母猪乳蛋白成分比较



(Fundamentals of Cheese Science, Patric F. Fox, et al, An Aspen Publication, 2000)

Protein Composition of Milk
Casein Fraction
牛奶中酪蛋白部分蛋白质组成

	% of Milk Protein 占乳蛋白%	% of Whole Dried Milk 占全干奶的%
Casein proteins酪蛋白中蛋白质	**78.4**	**20.4**
Alpha casein 阿尔法酪蛋白	**38**	**9.9**
Beta casein **β-**酪蛋白	**28**	**7.3**
Kappa casein K-酪蛋白	**10**	**2.6**
Gamma casein伽马-酪蛋白	**2.4**	**0.6**

Protein Composition of Milk Whey Fraction
乳清部分的蛋白比较

	% of Milk Protein 占乳蛋白%	% of Whole Dried Milk 占全干奶的%
Whey proteins 乳清蛋白	**21.8**	**5.7**
Beta-lactoglobulin β-乳球蛋白	**9.8**	**2.55**
Alpha-lactalbumin α-乳白蛋白	**3.7**	**0.96**
Serum albumin血清白蛋白	**1.2**	**0.31**
Proteose-peptone 月示蛋白胨	**2.4**	**0.62**
Immunoglobulins 免疫球蛋白	**2.4**	**0.62**
Membrane proteins 膜蛋白	**2.0**	**0.52**
Lactoferrin 乳铁蛋白	**0.16**	**0.04**
Lactoperoxidase 乳过氧化物酶	**0.13**	**0.03**

Casein and Whey Proteins
酪蛋白和乳清蛋白

- The major milk protein are the caseins.
  酪蛋白是主要的乳蛋白.
- Caseins form a curd in response to the acidic condition and enzymes of the stomach.
  在酸性条件下和胃酶的作用下,酪蛋白形成凝乳状.
- Both casein and whey proteins are highly digestible.
  酪蛋白和乳清蛋白都是极易消化的.

(University of Illinois Extension)

Casein is 100% digestible
酪蛋白是100%可消化的

- Casein has been shown to be completely digested by pigs (Peasons et al., 1982; Moughan and Smith, 1985; Kies et al., 1986; Wang and Fuller, 1989; Y. L. Yin, et al., 2004; Karsten, et al, 1999)

  酪蛋白已被证明是可以被完全消化的

- True digestibility of AA in casein is essentially 100% in both pigs and cockerels (T. K. Chung and David H Baker, 1992)

  猪和小公鸡 都可以100%地消化酪蛋白中的氨基酸

Functional Casein and Whey Proteins
酪蛋白和乳清蛋白的功能

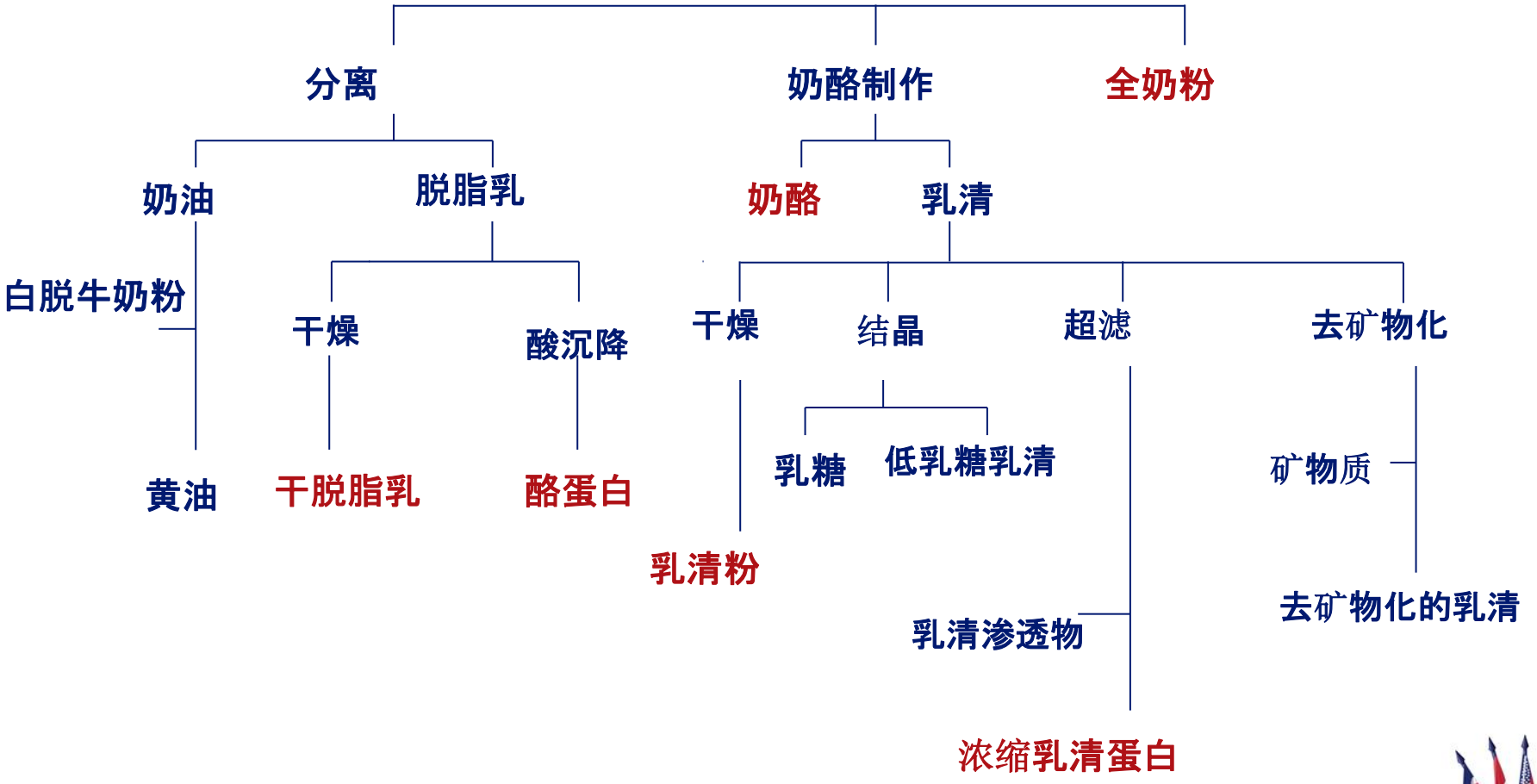
Biological Activity 生物活性	Milk Compound 牛奶成分
Antimicrobial action/wound healing 抗菌/伤口愈合	Lactoferrin, lactoperoxidase, lysozyme 乳铁蛋白，乳过氧化物酶，溶菌酶
Disease protection 疾病防护	Immunoglobulins, WPC 免疫球蛋白，乳清蛋白浓缩物
Anti-viral activity 抗病毒活性	Lactoferrin, lactoferricin, WPC 乳铁蛋白，乳铁蛋白肽，乳清蛋白浓缩物
Immunomodulating activity 免疫调节活性	Lactoferrin, alpha-lactalbumin, casein glycomacropeptide, WPC 乳铁蛋白，α-乳蛋白，酪蛋白巨肽，乳清蛋白浓缩物
Anti-bacterial toxin activity 抗菌和细菌毒素作用	Lactoferrin, casein glycomacropeptide, beta-lactoglobulin, alpha-lactalbumin 乳铁蛋白，酪蛋白巨肽，β-乳球蛋白，α-乳蛋白
Anti-cancer activity 抗癌	Alpha-lactalbumin, lactoferrin, WPC, α-乳蛋白，乳铁蛋白，乳清蛋白浓缩物
Prebiotic 益生素	Casein glycomacropeptide 酪蛋白巨肽

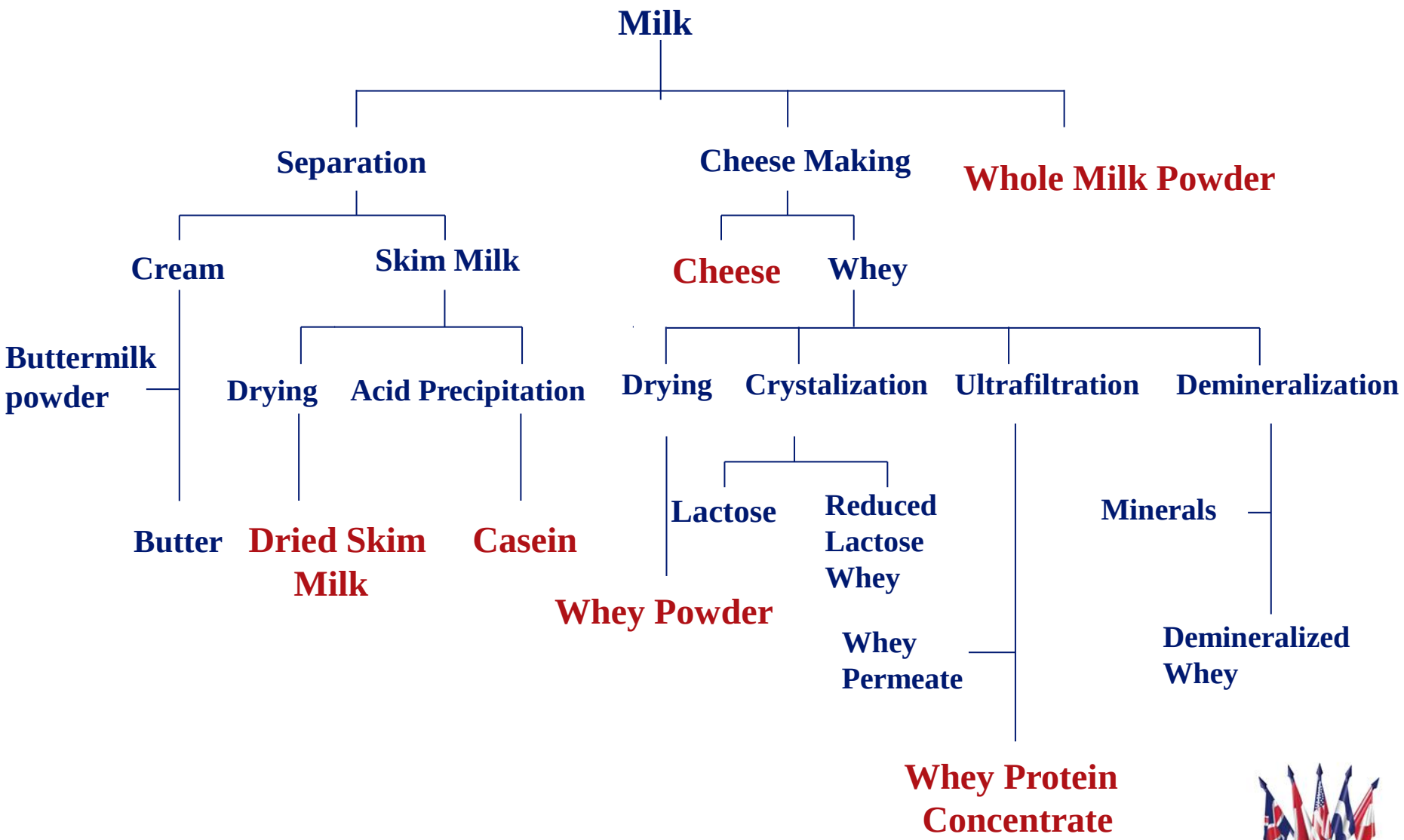
Commercial Sources of Milk Proteins
乳蛋白商业来源

Sources of Milk Protein
乳蛋白源

- Whole milk powder全脂奶粉
- Skim milk powder脱脂奶粉
- Casein酪蛋白
- Cheese powder奶酪粉
- Whey powder乳清粉
- Whey protein concentrate
  浓缩乳清粉

全乳


分离
奶酪制作
全奶粉
奶油
脱脂乳
奶酪
乳清
白脱牛奶粉
干燥
酸沉降
干燥
结晶
超滤
去矿物化
黄油
干脱脂乳
酪蛋白
乳糖
低乳糖乳清
矿物质
乳清粉
乳清渗透物
去矿物化的乳清
浓缩乳清蛋白


Milk
Separation
Cheese Making
Whole Milk Powder
Cream
Skim Milk
Cheese
Whey
Buttermilk powder
Drying
Acid Precipitation
Drying
Crystalization
Ultrafiltration
Demineralization
Lactose
Reduced Lactose Whey
Minerals
Butter
Dried Skim Milk
Casein
Whey Powder
Whey Permeate
Demineralized Whey
Whey Protein Concentrate

Milk Fat
乳脂肪

Milk Composition Comparison (%, liquid basis)
不同乳源成分比较(%，液态)

	Fat 脂肪	Protein 蛋白质	Lactose 乳糖	Minerals 矿物质	Solid 固体
Cow 奶牛	3.5	3.1	4.9	0.70	12.2
Sow 母猪	8.2	5.8	4.8	0.60	19.4

Source: “Milk Composition-Species Table”, University of Illinois

Milk Fat is Key Energy Source For Piglets
乳脂肪是仔猪主要的能量来源

- Sow milk (7 to 8% fat on average) is higher in fat than cow milk (3 to 5%), but is extremely variable among breed.

  母猪奶平均脂肪含量（7%-8%）比牛奶（3%-5%）更高，
  但在不同种群见差异较大。

- The neonatal pig has less than 2% body fat and almost no subcutaneous fat. It is very crucial to have milk fat as an energy supply for their survival.

  新生仔猪体内脂肪含量小于2%，甚至没有皮下脂肪。
  因此，乳脂肪对于新生仔猪来说是非常重要的能源。

Composition Comparison of Milk Fat vs. Other Common Fat Sources
乳脂肪和其他来源脂肪的成分比较

- Cow milk fat contains more saturated fat (76%) than beef tallow, pork lard, and vegetable oils.

  奶牛的乳脂肪比牛脂、猪油和植物油相比含有更多的饱和脂肪(76%)。

- Cow milk contains more short and medium chain fatty acids than tallow, pork lard, and common vegetable oils.

  乳脂肪比牛脂、猪油和植物油相比含有更多的短链和中链脂肪酸。

Fatty Acid Composition of Cow Milk
牛奶中脂肪酸的组成

Fatty Acid 脂肪酸	% of Lipid Composition 占总含量百分比
C2:0 to C6:0	6%
C8:0 to C12:0	12%
C14:0	15%
C16:0	37%
C16:1	3%
C18:0	6%
C18:1	16%
C18:2	4%
C18:3	1%

Fatty Acid Composition of Commonly Used Fat Sources in Animal Feeds
动物饲料中常见脂肪源的脂肪酸组成

Fatty Acid Saturation 脂肪酸饱和度	Sow's Milk 母猪奶	Cow's Milk 牛奶	Palm Oil 棕榈油	Choice White Grease 精选白色动物油	Tallow 牛油	Soy Oil 大豆油	Corn Oil 玉米油
Saturated 4:0 to 18:0 饱和 4:0 到 18:0	39.8	76.5	50.0	38.9	48.4	14.2	13.0
Monounsaturated 16:1 & 18:1 单不饱和的 16:1 & 18:1	40.4	18.8	40.0	43.9	40.2	23.0	28.0
Polyunsaturated 18:2 多不饱和的 18:2	17.9	3.6	10.0	10.2	3.1	51.0	58.0

Fatty Acid Composition of Commonly Used Fat Sources in Animal Feeds
动物饲料中常见脂肪源的脂肪酸组成

Fatty Acid Chain length 脂肪酸链长	Sow's Milk 母猪奶	Cow's Milk 牛奶	Palm oil 棕榈油	Choice White Grease 精选白色动物油	Tallow 牛脂	Soy Oil 大豆油	Corn Oil 玉米油
Short Chains <8 短链＜8	0	6.3	0	0	0	0	0
Medium Chains 8-12 中链8-12	1.1	11.7	0	0.3	0.9	0	0
Long Chains >12 长链＞12	98.9	82.07	100	94.7	91.7	95.2	100

Nursing Pigs Effectively Use Milk Fat
乳脂肪在保育猪中的有效利用

- Nursing pigs are capable of effectively using milk fat due to high lipase activity in piglet digestive system and the emulsified form of milk fat.

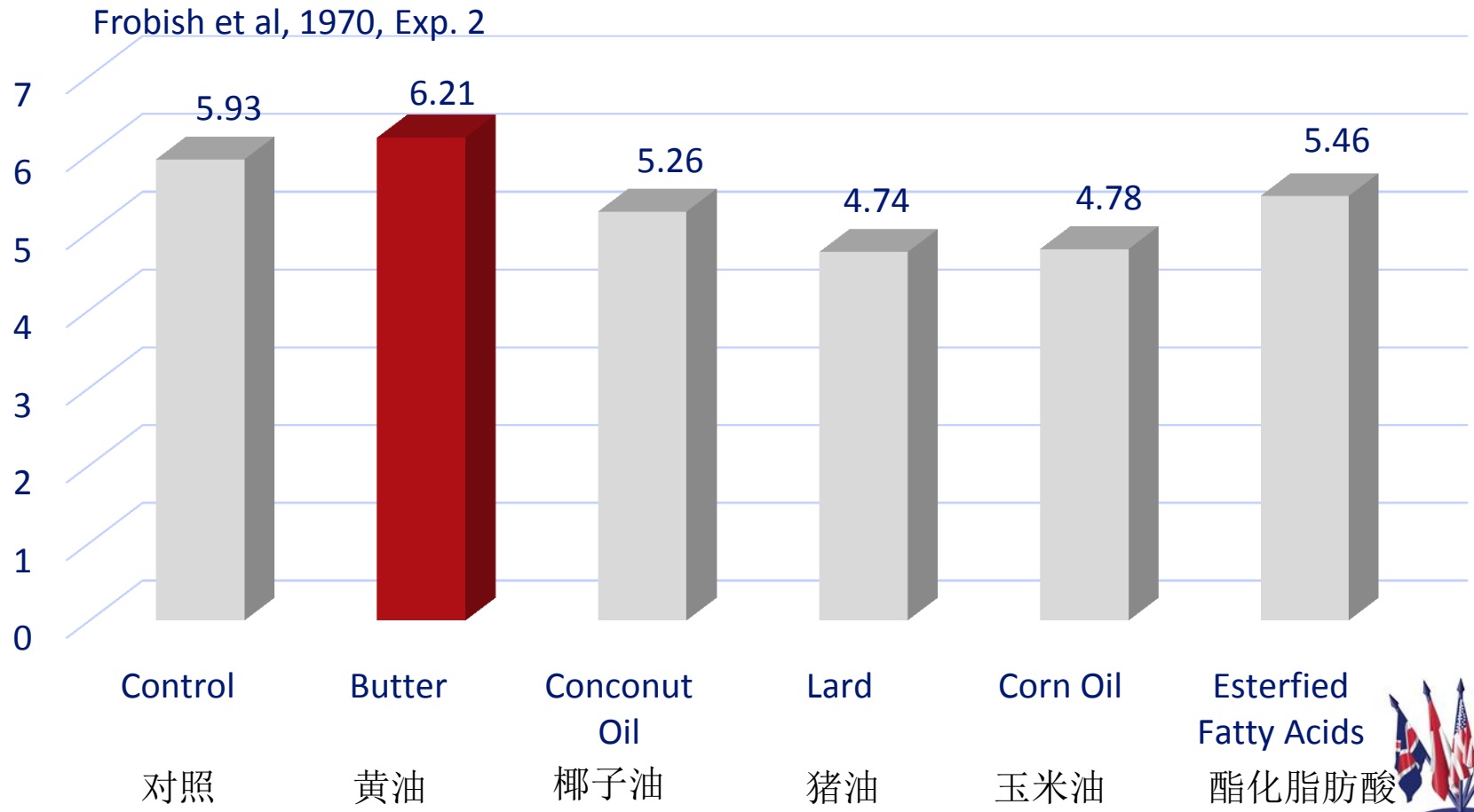
  保育猪可以有效利用乳脂肪和乳化形式的乳脂肪，

  这是由于其消化系统中有较高的脂肪酶。

- Frobish et al, (1967) found that the digestibility of milk fat by 2 day old pigs was 95%.

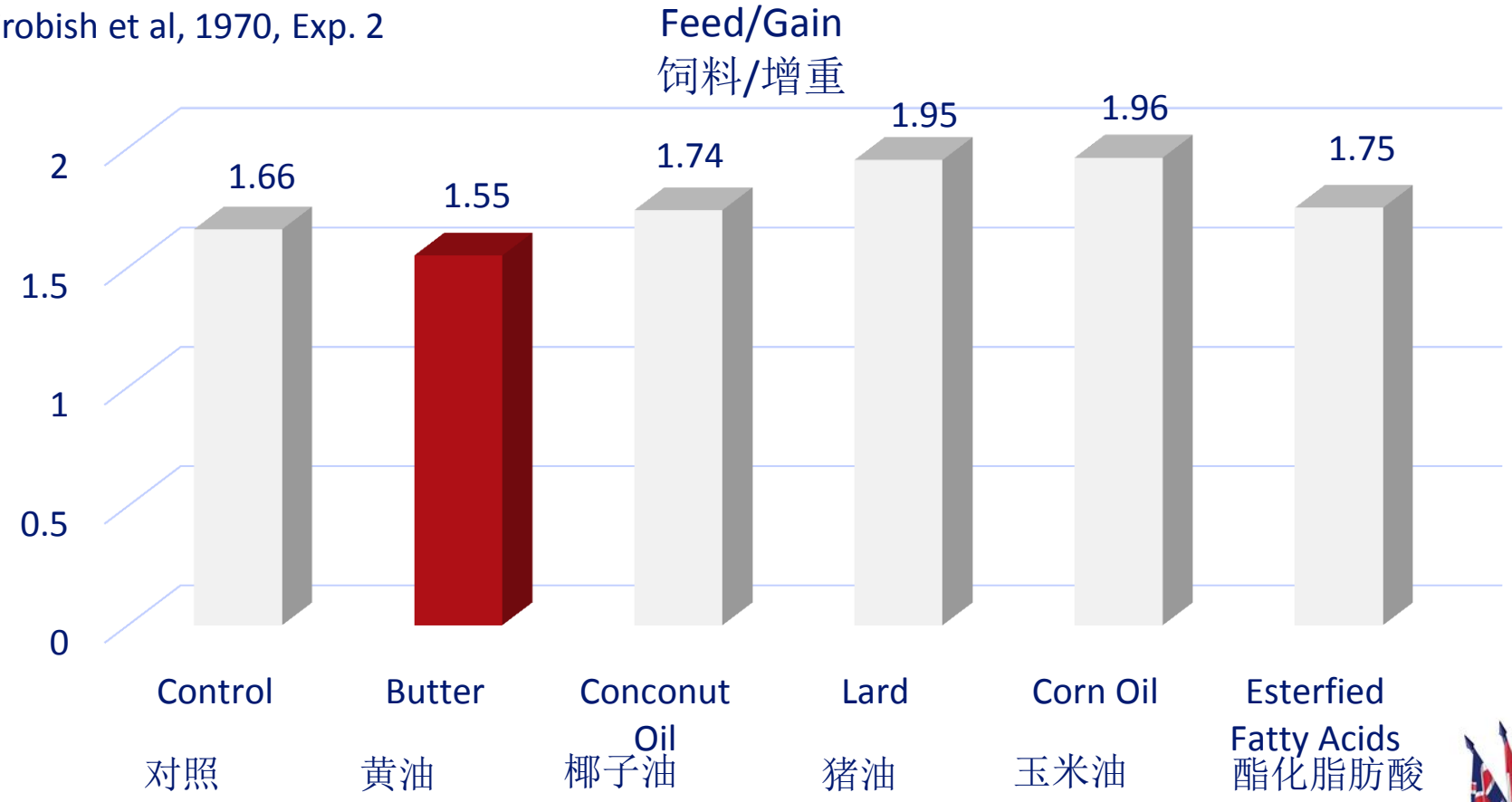
  Frobish发现，2日龄仔猪的乳脂肪消化率为95%。

Effect of Fat Source on Average Total Gain During 13 Day Trial (kg, age 16 to 28 d)
16-28日龄猪在13天试验中脂肪的平均增重效果



Effect of Fat Source on Feed/ Gain Ratio During 13 Day Trial (age 16 to 28 days)
16-28日龄猪在13天试验中脂肪的饲料/增重比效果

Frobish et al, 1970, Exp. 2



Antimicrobial Function of Milk Fat
乳脂肪的抗菌作用

- Milk Fat triglycerides contain C10:0 and C12:0 fatty acids that were able to exert a bactericidal effects against *Campylobacter jejuni and L moncytogenes* (Sprong et al, 2002).

  牛奶中的脂肪甘油三酯含有的C10:0和C12:0脂肪酸能够发挥抵抗空肠弯曲杆菌和产单核李斯特菌的作用。

- Components of MFGM such as glycosphingolipids were able to bind eterotoxingenic E. Coli strains and potentially render them unable to colonize the intestine(Sanchez-Junes et al, 2009).

  乳脂球膜中的某些成分如糖鞘脂类可以抑制肠产毒性大肠杆菌，并使其无法在肠道寄生。

Conclusions 结论

1. Sow's milk is high in fat (37% DM basis), protein (30%) and lactose (29%). Baby pigs have the enzyme system to effectively digest milk nutrients.

猪奶中含有较高的脂肪 (37% 基于干物质), 蛋白 (30%) 和乳糖 (29%), 仔猪具备有效消化奶中营养的酶系统。

2. Milk protein has an excellent amino acid balance, very similar to the "ideal" amino acid balance required by the nursery pig.

牛奶乳蛋白具有非常好的的氨基酸平衡，这和保育猪的理想需求平衡非常相似。

3. Amino acid digestibility is superior in milk protein, higher than other animal and plant protein.

牛奶乳蛋白中的氨基酸可消化性高于其它的动物和植物蛋白。

Conclusions (con't)结论

4. Cow's milk is approximately 80% casein protein and 20% whey protein (expressed as % of protein). Both are readily digestible.

牛奶含有大约80%的酪蛋白和20%的乳清蛋白(表现为蛋白质百分比)，两者都很容易被消化。

5. Milk contains functional (bioactive) whey proteins that are important for pig health. These proteins include immunoglobulins, lactoferrin, lactoperoxidase, and others.

牛奶中含有的功能性(生物活性)乳清蛋白对生猪健康很重要。这些蛋白主要有免疫球蛋白、乳铁蛋白、乳过氧化物酶和其他类蛋白。

Conclusions (con't)结论

6. Milk fat is a crucial energy source for newborn and early age piglets.

乳脂肪对于新生和早期仔猪是非常重要的能量来源。

7. Milk fat has a unique fatty acid profile with more saturated and short-chained fatty acids compared with tallow, lard and most vegetable oils.

乳脂具有独特的脂肪酸属性,和牛脂,猪油以及大多数植物油相比, 它具有更多的饱和脂肪酸和短链脂肪酸。

8. Milk fat is a highly digestible energy source for young piglets which promotes better growth and feed efficiency compared to other common fat source

对于仔猪来说, 乳脂是极易消化的能量来源。与其他脂肪源相比, 它能促进生长并提高饲料利用率。

Complimentary Products
赠送产品？

Dairylac® 80 = Lactose source

Dairylac® 80 = 乳糖

Cheese Plus Cheese = Milk protein & fat source

奇饲粉(奶酪粉) = 乳蛋白&脂肪

INTERNATIONAL
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