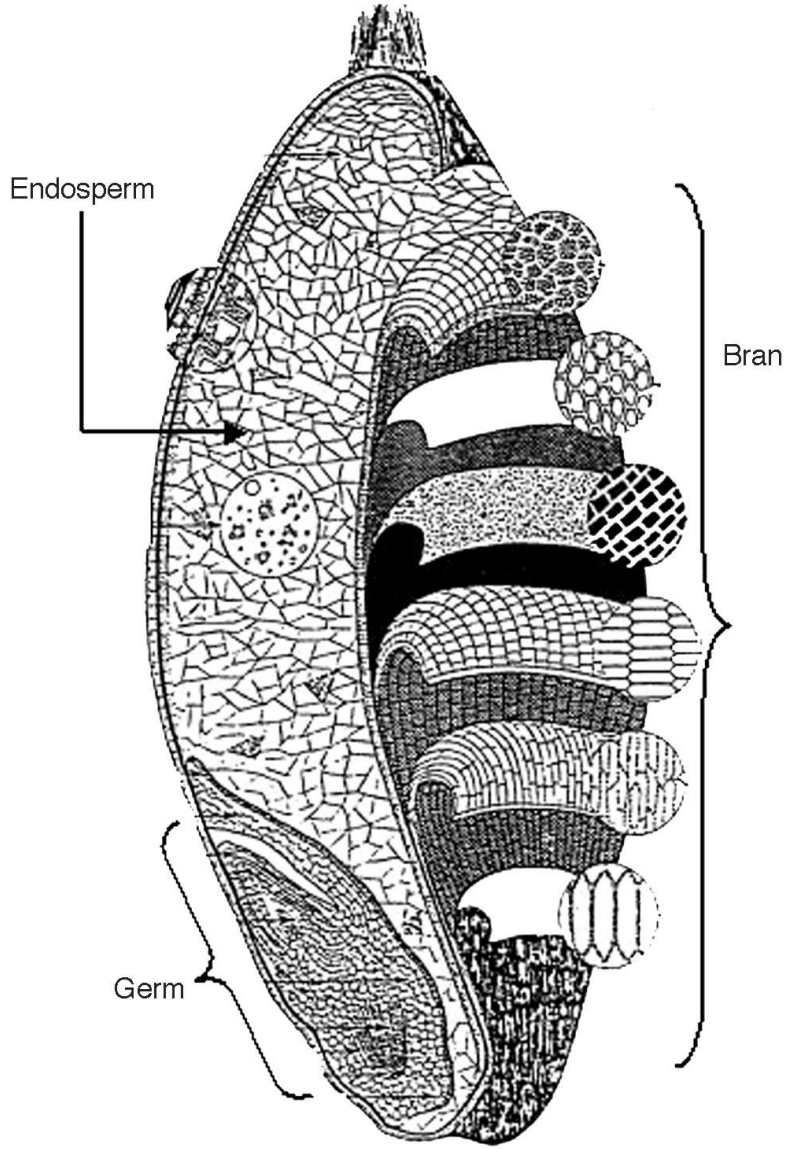
The Classification and Production of Whole Wheat Flour in the U.S.
美国全麦粉的分类及生产

Whole Wheat Flour 全麦粉(WWF)

- Whole grains shall consist of the intact, ground, cracked or flaked caryopsis, whose principal anatomical components—the starchy endosperm, germ, and bran—are present in the same relative proportions as they exist in the intact caryopsis. – AACCI Whole Grains Definition (1999)
- 全谷物应含整粒、磨碎、破碎或压扁的谷物颖果，从解剖学意义上说的含有其全部组分-含淀粉的胚乳，胚芽及麸皮-并保持其在原颖果时相同的比例。-AACCI全谷物定义（1999年）



Market Information 市场信息

- 2005 USDA Dietary Guidelines suggested that half of grains consumed should come from whole grains (USDA 2005)
- 2005年美国农业部居民膳食指南建议摄入的谷物中一半应为全谷物（美国农业部2005年）
- The average fiber intake for adults across North America, Europe, and Asia varied from 9 to 24 g/day, has been below the WHO/FAO recommended range of 40 g/day
- 北美、欧洲和亚洲成年人的平均纤维摄入量从9克/天到24克/天不等，低于世界卫生组织/粮农组织建议的40克/天的范围
- Whole wheat flour production accounted for 4.3% of total U.S. flour production in 2023 (Milling and Baking News)
- 2023年，全麦粉的产量占美国面粉总产量的4.3%。
- 4.58 million hundredweight were produced in the 4th Q of 2023
- 2023年第四季度生产了458万英担（23万吨）全麦粉。

Whole Wheat Flour Types 全麦粉类型

- High extraction 高出率面粉
  - Approximately an 85% extraction 出率大约为85%
  - Milled to a WWF with some bran and germ sifted out 磨成全麦粉，筛出一些麸皮和胚芽
  - Milled from hard and soft wheats 由硬麦和软麦磨成
- Whole wheat bread flour 全麦面包粉
  - Milled from hard wheats (Hard red winter, hard red spring, or hard white) 由硬麦磨成（硬红冬麦、硬红春麦、或硬白麦）
- Whole wheat pastry flour 全麦糕点粉
  - Milled from soft wheat (Soft red winter, Soft white) 由软麦磨成（软红冬麦、软白麦）
- Whole wheat all-purpose flour 全麦通用粉
  - Milled from a soft and hard wheat blend or hard red winter 由软麦和硬麦配麦，或硬红冬麦磨成

Types of Whole Wheat Milling Equipment
全麦粉制粉设备类型

Types of Whole Wheat Milling Equipment
全麦粉制粉设备类型

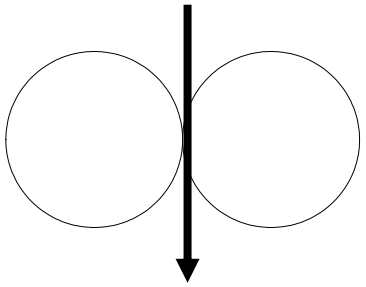
- Stone Mill 石磨
- Steel Roller Mill 辊磨
- Hammermill 锤片磨

Stone Mill 石磨

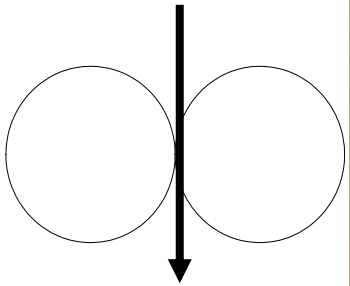
- Single stage milling 一次制粉
- Utilizes compression, shear, and abrasion 利用挤压、剪切和磨损力
- Modern mills use metal plates with attached composition stones attached 现代面粉厂使用钢板并附加合成石
- Generate heat during grinding 研磨时产热
  - Stones can reach temperatures of 90 °C 石块温度可达到90℃
  - Generally, produce flour with higher damage starch 通常生产的面粉破损淀粉较高
  - Induce loss of amino acids and unsaturated fatty acids 导致氨基酸和不饱和脂肪酸的损失
- Tend to produce coarse particle size WWF 往往生产出粗粒度的全麦粉
- Not commonly used on commercial scale due to poor efficiency 由于生产效率差，不常用于商业生产。

Steel Roller Mill 辊磨

- Single and multiple stage milling 一次或多次制粉
- Utilizes compression and shear forces 利用挤压和剪切力
- The amount of grinding and reduction at each roll can be adjusted 齿辊和光辊的研磨程度均可调
- Optimize roll corrugations and roll differential 优化磨辊磨齿和磨辊速比
- Reduced heat build up on rolls which result in less destruction to chemical components 减少了磨辊上的热量积聚，从而减少了对化学成分的破坏
  - Less starch damage compared stone milling (5-7%) 比石磨相比，破损淀粉较少（5-7%）
- Wheat bran and germ can be separated from the endosperm fraction with subsequent sifting 麦麸和胚芽可通过后续筛分从胚乳中分离出来
- Most common equipment used in WWF milling 全麦粉制粉中最常见的设备



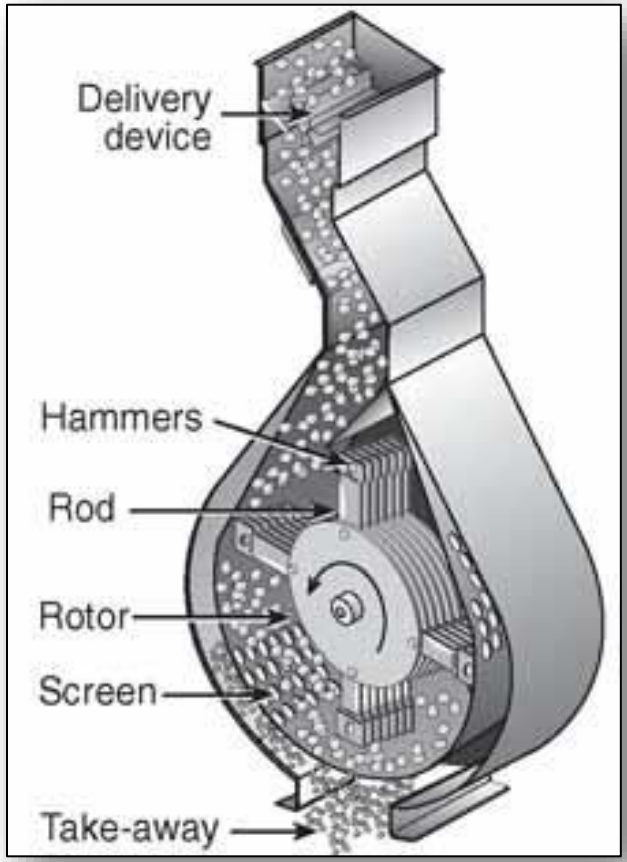
Horizontal corrugated 平置齿磨



Horizontal smooth 平置光磨

Hammermill 锤片磨

- Single stage milling 一次制粉
- Critical variables are the tip speed of the hammers, hammer arrangement, screen size 关键变量是锤头速度，锤头排列，筛网尺寸
- Can be used to mill coarse bran after initial roller milling 可用在初始辊磨制粉后来磨粗麸片
- Not commonly used on commercial scale production of WWF 不常用于全麦粉的商业规模生产
- Generate temperatures up to 55 °C 产热使温度升高至55°C
- Damaged starch reported at 8-9% 破损淀粉含量为8-9%



Whole Wheat Flour Preparation and Milling
全麦粉磨粉前制备及制粉

Whole Wheat Flour Milling Preparation 全麦粉磨粉前制备

Preparation制备

- Blend different wheat varieties from various locations 不同地区不同品种的小麦进行配麦
- Clean 清理

Tempering 润麦

- Add 1 – 2% moisture or hit a target moisture content (14.5%) 加入1-2%的水或达到目标水分含量(14.5%)
- Optional 可选

- Tempering is not required for production of WWF 生产全麦粉不需要润麦
- Soften the grain and improve efficiency in energy required to mill WWF 生产全麦粉，需要软化籽粒，提高能效
- Milling tempered wheat results in a coarser particle size WWF compared to milling un-tempered wheat 与未润麦的小麦相比，润麦后的小麦生产出粒度较粗的全麦粉

Single Stream Whole Wheat Flour Milling 单粉路全麦粉制粉

Equipment 设备

- Use a stone mill, roller mill with corrugations, or hammermill 使用石磨、带磨齿的辊磨，或锤磨

Milling 制粉

- Wheat enters the mill and is ground in one pass 小麦进入磨机，一次磨碎
- Ground wheat is in the same proportions as the intact kernel 磨碎的小麦和完整的麦粒的组分比例是一样的

- Single stream mills are mills that grind the grain in one operation and where the resultant whole wheat flour is neither sifted, separated, or re-ground 单粉路制粉是指一次将谷物研磨，所得的全麦粉既不经过筛分、分离也不重新研磨
- Least common method for commercial whole wheat flour production 商业全麦面粉生产中最不常见的方法
- Flour tends to have a larger particle size compared to multiple stage milling 与多次制粉相比，所得的面粉往往粒度较大

Multiple Stream Whole Wheat Flour Milling 多粉路全麦粉制粉

Equipment 设备

- Use a series of roller mills and sifters 使用一系列的辊磨和筛粉机
- Endosperm is separated from bran and germ and ground separately 胚乳与麸皮和胚芽分离，分开研磨

Milling 制粉

- Mill flow used to create multiple streams - Grind -> Sift -> Grind -> Sift 存在多道粉路 – 研磨-筛分-研磨-筛分
- Coarse material is sent back for further milling and sifting 粗粒度物料送回，进行进一步研磨和筛分

Milling 制粉

- The endosperm, germ, and bran are recombined in continuous process 在连续性进程下，胚乳、胚芽和麸皮重组
- All components are present in the same proportions as the intact kernel 所有的组分与完整籽粒比例相同

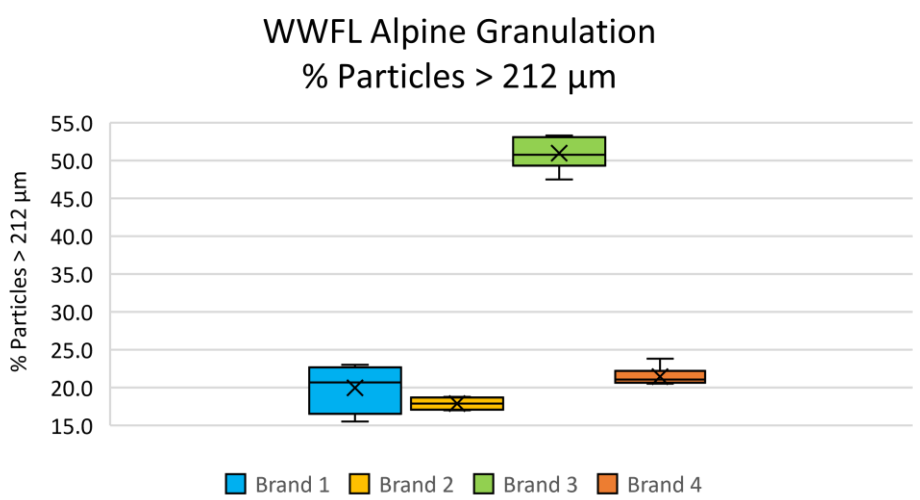
- Recombination using a multiple stream method is the most common method for commercial whole wheat flour production 多粉路重组法是最常见的商业化生产全麦粉方法。
- Millstreams may be sifted and separated by particle size 粉路可以按粒度进行筛分
- Bran may undergo additional fine grinding (hammermill) 麸皮可以额外磨细（锤磨）
- Creates a WWF with a more uniform particle size 生产出的全麦粉粒径更均一

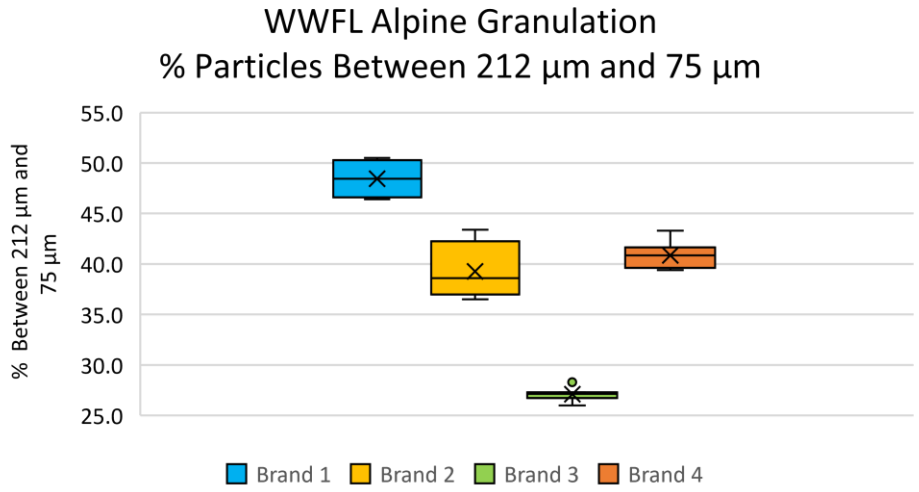
Whole Wheat Flour Quality Considerations
全麦粉质量注意事项

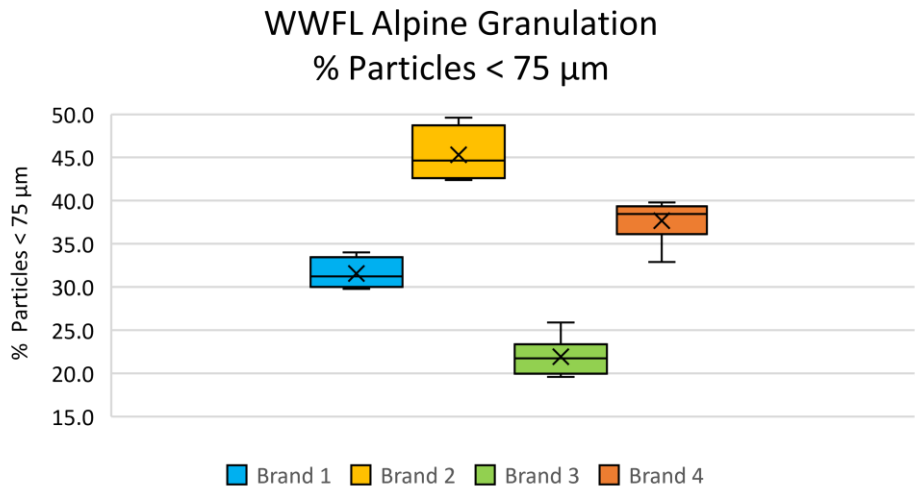
Particle Size 粒度

- The milling method affects particle size distribution 制粉方式影响粒度分布
- There can be significant differences in WWF particle size distribution across flour brands and milling companies 不同面粉品牌和面粉厂的全麦粉的粒度分布可能存在显著差异
- The effect of bran particle size on dough properties and bread quality are not consistent among studies 各项研究显示，麸皮粒度对面团特性和面包品质的影响不一致
  - Variation in bran composition and methods used to prepare bran 麸皮成分的变化和制备麸皮的方法
  - Bakers must determine what specifications work best for their product/process 烘焙师必须确定什么规格最适合他们的产品/工艺
- Incorporation of fibers into white wheat flour tends to increase the starch retrogradation and bread staling 在白面中掺入纤维会增加淀粉回生和面包老化
- More starch retrogradation in bread crumb was observed in WWFs of fine bran than those of coarse bran 细麸皮粒度的全麦粉比粗麸皮粒度的全麦粉生产的面包瓤淀粉回生更多。

Whole Wheat Flour Particle Size 全麦粉粒度







Starch Damage 破损淀粉

- Starch damage may better indicate milling severity than the heat generated during the milling process 破损淀粉反应了研磨强度，而不是在制粉过程中产热的多少
- The milling method affects degree of starch damage 制粉方式影响破损淀粉的程度
- In yeast breads, some damaged starch is desirable 在酵母发酵面包中，存在一些破损淀粉是有利的
- The amount of amylopectin retrogradation and breadcrumb firming increased with the damaged starch content 随着破损淀粉含量增加，支链淀粉回生增多、面包瓤硬化增加
- Damaged starch can increase initial water absorption and prevent optimum gluten formation during mixing 破损淀粉会增加初始的吸水率，在搅拌过程中阻碍了面筋的最佳形成
- Dough consistency can decrease and lose gas retention capacity after starch degradation during fermentation phase. 在发酵阶段，淀粉损坏后，面团稠度降低，保气能力失去

Thank You谢谢!!
Questions问题??