Whole Grain Milling: Future Nutrition Security

April 23, 2025

Learning Objective

- Compare the nutritional impact of different milling methods on grains.

Housekeeping

- Attendees will receive an email within ONE WEEK with **CPEU certificate**, **slides**, and **recording**
- Please submit any questions using the Q&A function in Zoom.
- Stay tuned for the interactive assessment

Join Us Next Wednesday (April 30, 2025) for The Whole Grain Academy

10:00am ET

Webinar

Biodiversity in the Mediterranean Diet:

Exploring the Impact of Naturally Gluten-Free Whole Grains

April 30
10:00 AM E.T.

This webinar awards **1 CPEU** accordance with the Commission on Dietetic Registration's CPEU Prior Approval Program.

Noon ET

Webinar

Cooking Demo:

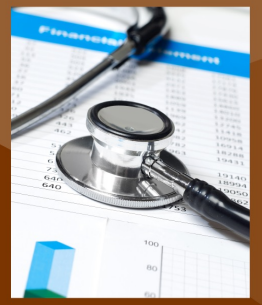
Whole Grains at Breakfast, Lunch, and Dinner

April 30
12:00 PM E.T.

2:00pm ET

Webinar

Leveraging Whole Grains to Reduce Healthcare Spending



April 30
2:00 PM E.T.

This webinar awards **1 CPEU** accordance with the Commission on Dietetic Registration's CPEU Prior Approval Program.

5:00pm ET

Webinar

Understanding Whole Grain Food Processing and the Limitations of the Nova Classification System

April 30
5:00 PM E.T.

This webinar awards **1 CPEU** accordance with the Commission on Dietetic Registration's CPEU Prior Approval Program.

Whole Grain Milling: Future Nutrition Security

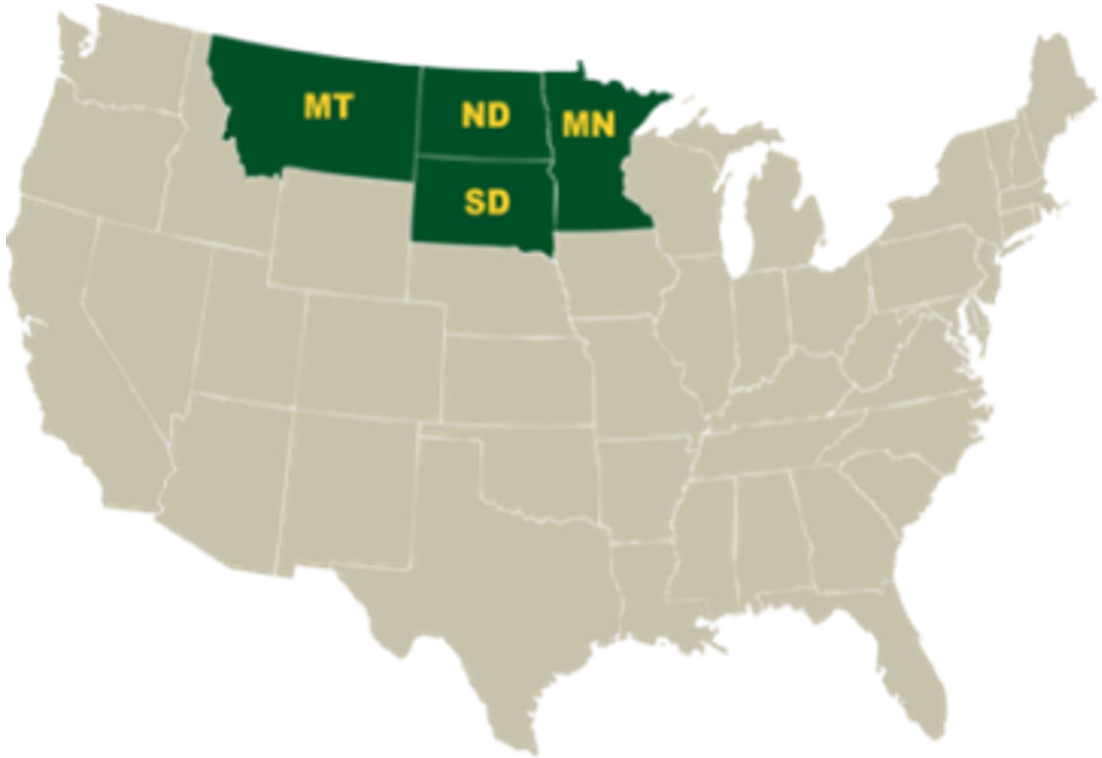
Amrita Ray, PhD

DISCLOSURES

No commercial support or funding was provided for this webinar.

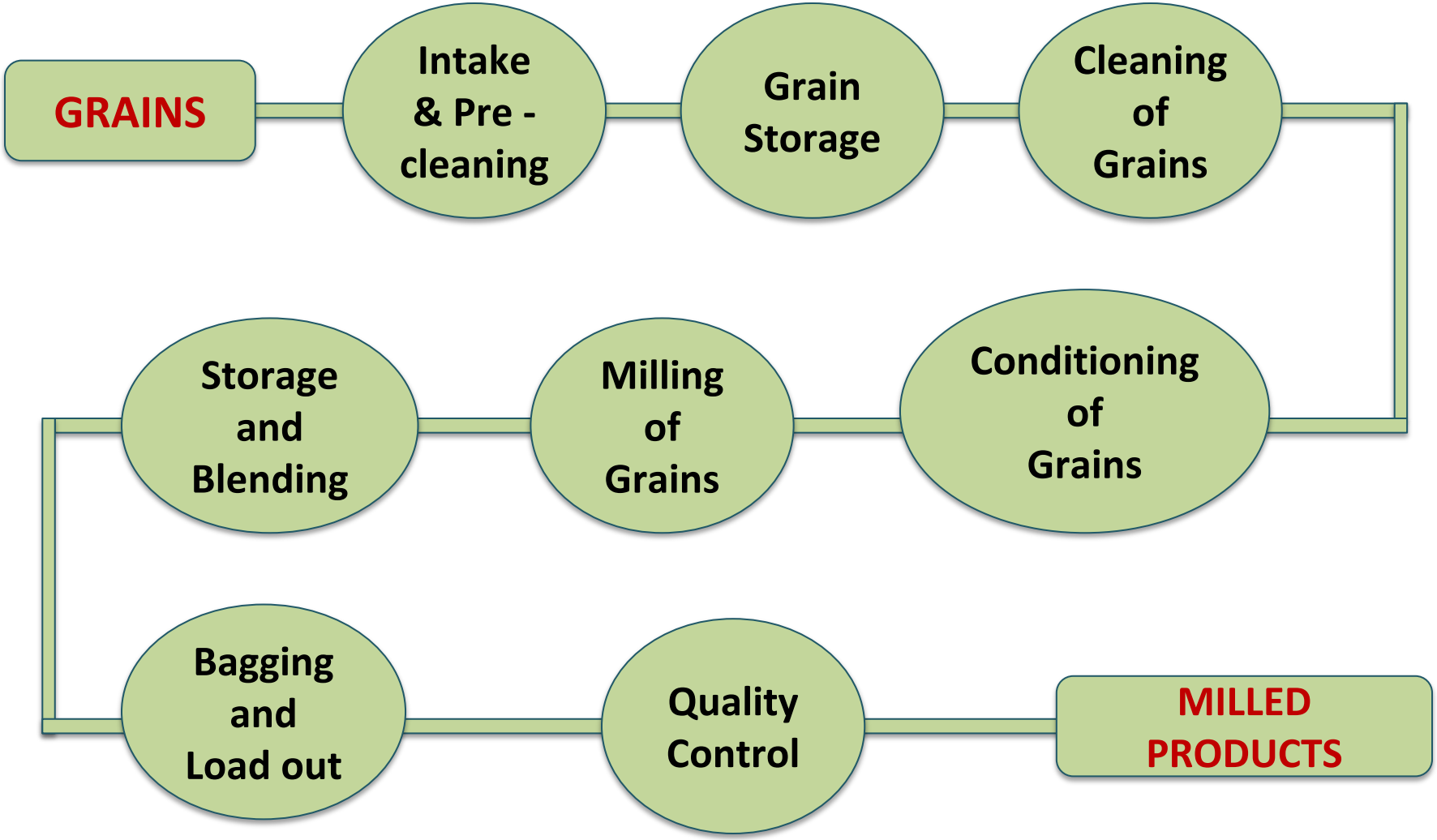
Employee of Northern Crops Institute, a four-state collaboration based at North Dakota State University in Fargo, ND.

RESEARCH & EDUCATION



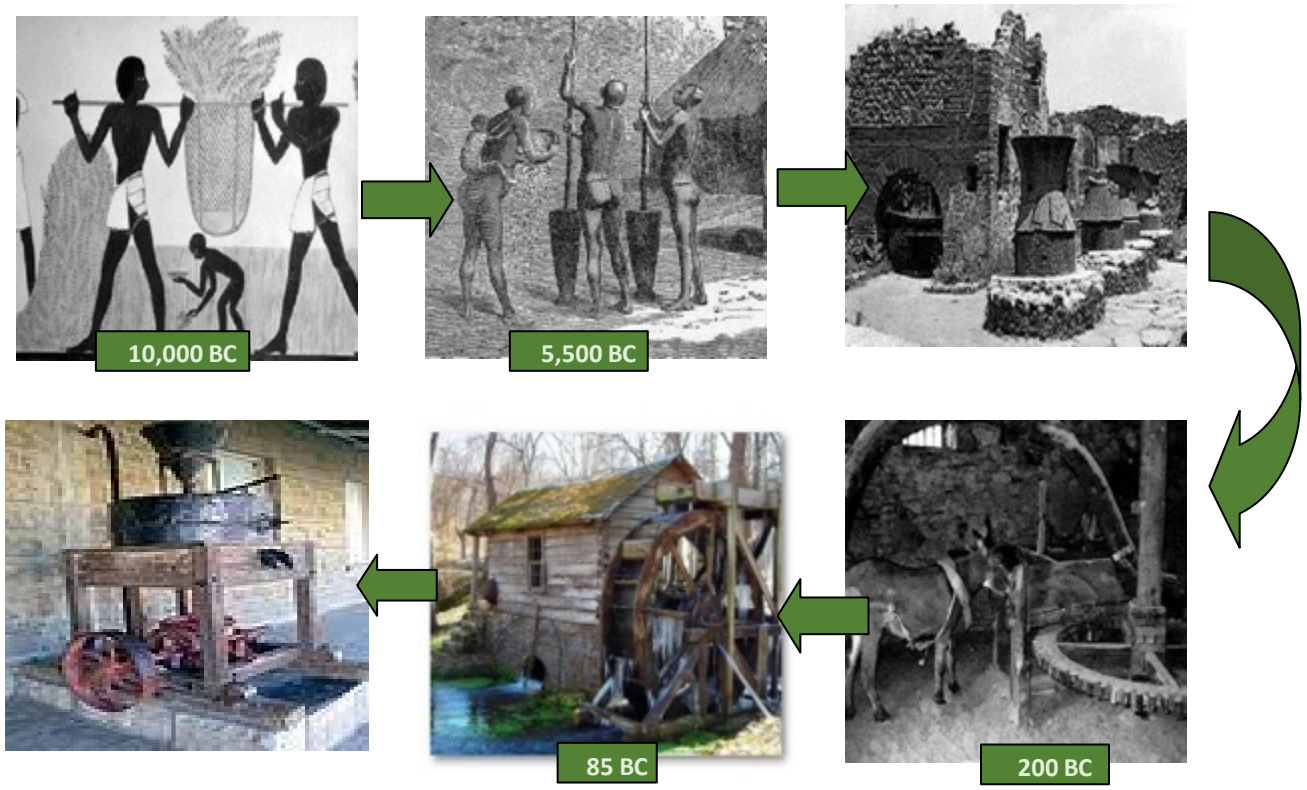
We are proud to serve as a global meeting place

GRAIN PROCESSING



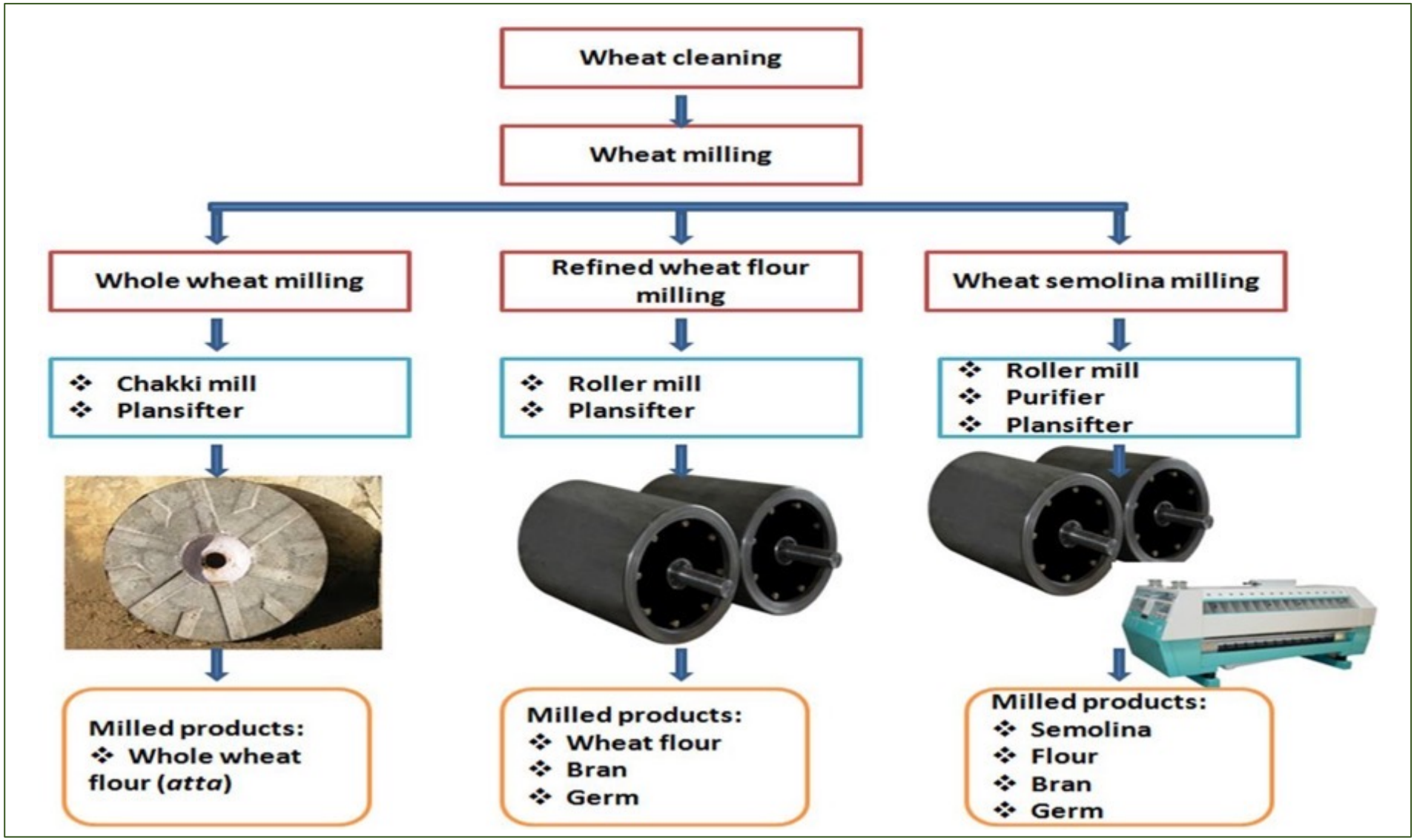
HISTORY OF MILLING

- **Ancient Beginnings**: Early civilizations used hand-operated, mortar and pestle, querns (simple grinding stones) to mill grains
- **Animal Run**: To improve efficiency in grinding
- **Water & Wind Power**: Introduction of watermills and windmills in the Middle Ages mechanized milling, increasing output

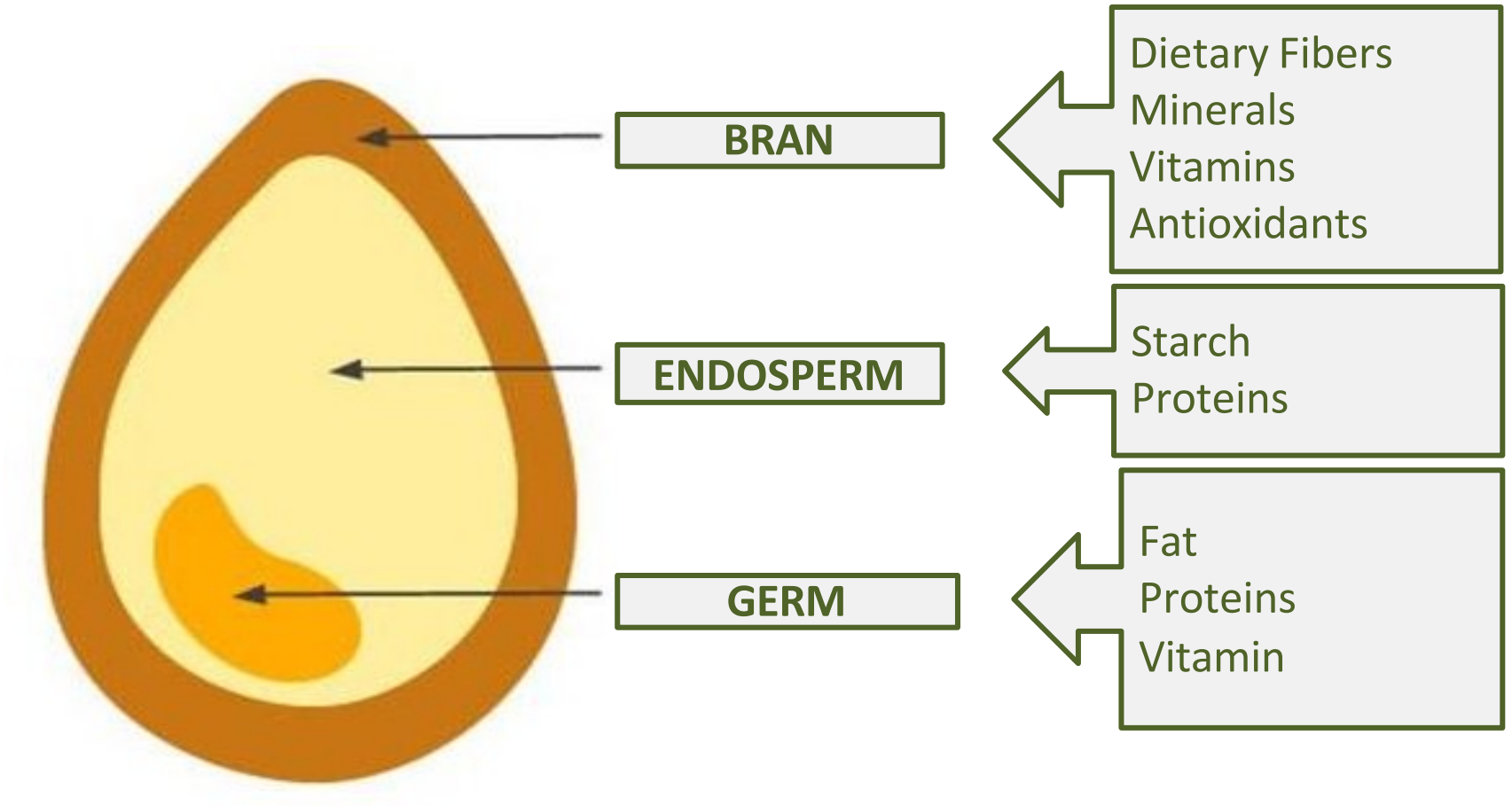


- **Industrial Advancements**: The 19th century saw steel rollers replace some stone mills due to higher capacity, capacity for grain fractionation and refining but stone milling remained for artisanal and whole grain flours
- **Modern Revival**: Resurgence in 21st century; today, it is valued for its ability to preserve nutrients and flavors

TYPICAL PROCESSING TECHNOLOGIES



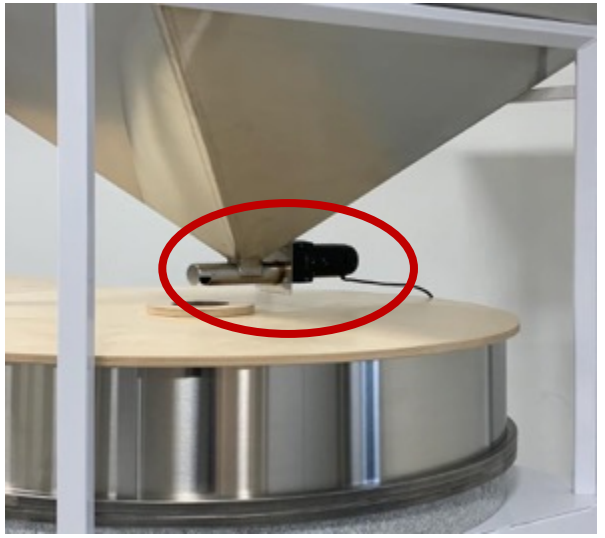
GRAIN STRUCTURE



- **Whole grain milling:** Bran, endosperm and germ are present in the same relative proportion as intact grain
- **Refined flour milling:** Removal of endosperm from bran and germ, following conversion of endosperm into flour/semolina

STONE MILL

- Machine consists of hopper with a grain feeder
- A pair of horizontal circular stones placed one on top of the other
- One stone rotates or "runner" and the other is fixed
- The grinding occurs in between the stones surface that has a series of furrows



- Several physical forces: shear, compression, and abrasion leads to unique flour properties
- Grains enter at the center of the stone and moves towards periphery by centrifugal forces
- The degree of fineness of flour is controlled by adjusting the gap between two stones

THE TIMELESS TRADITION WITH MODERN MAKE OVER

Saddle Quern

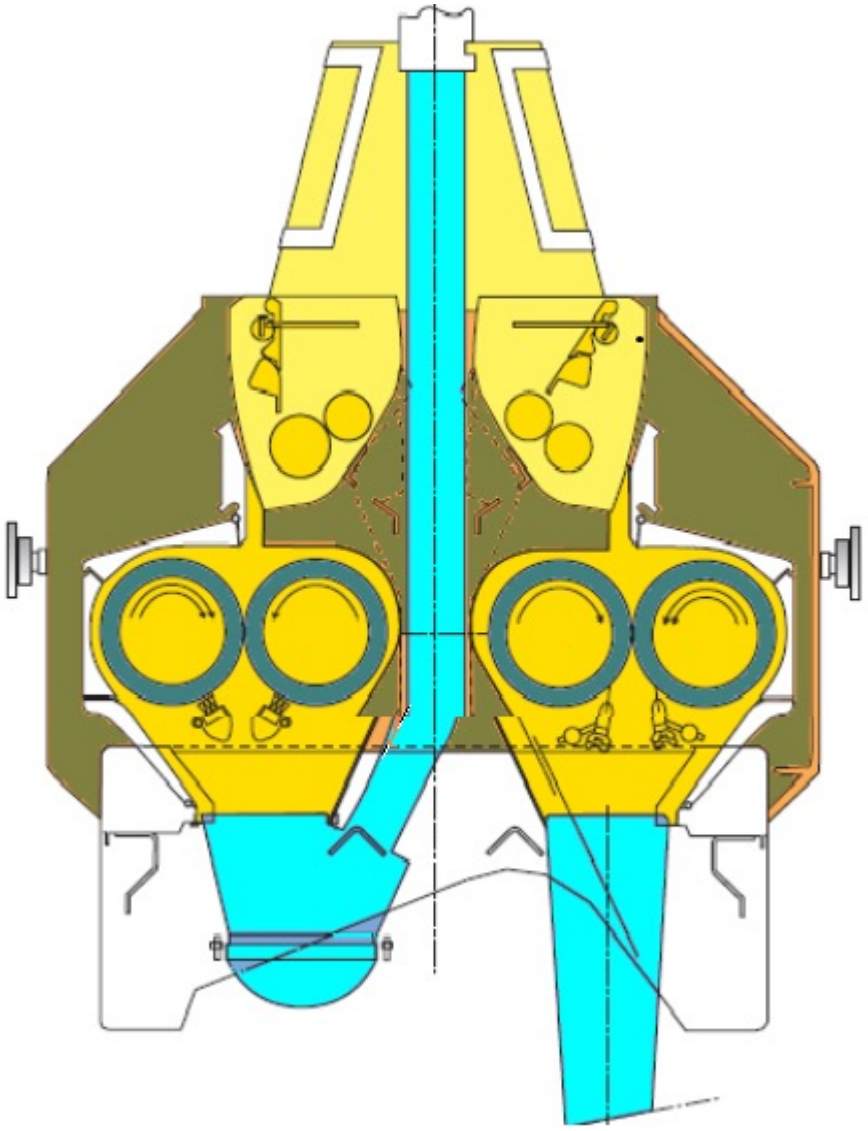
Grinding Stone

Mill

Modern Stone Mill

- All the botanical components of the grain (bran, endosperm, germ) are present in the same relative proportion as intact grain kernels
- Nutrients are unevenly distributed in the grain; removal of specific grain components leads to the loss of those nutrients
- A suitable choice for milling in the future, particularly in the wake of nutrition security
- Flexible capacity: small-scale artisan milling facility or a large scale plant for commercial production

ROLLER MILL

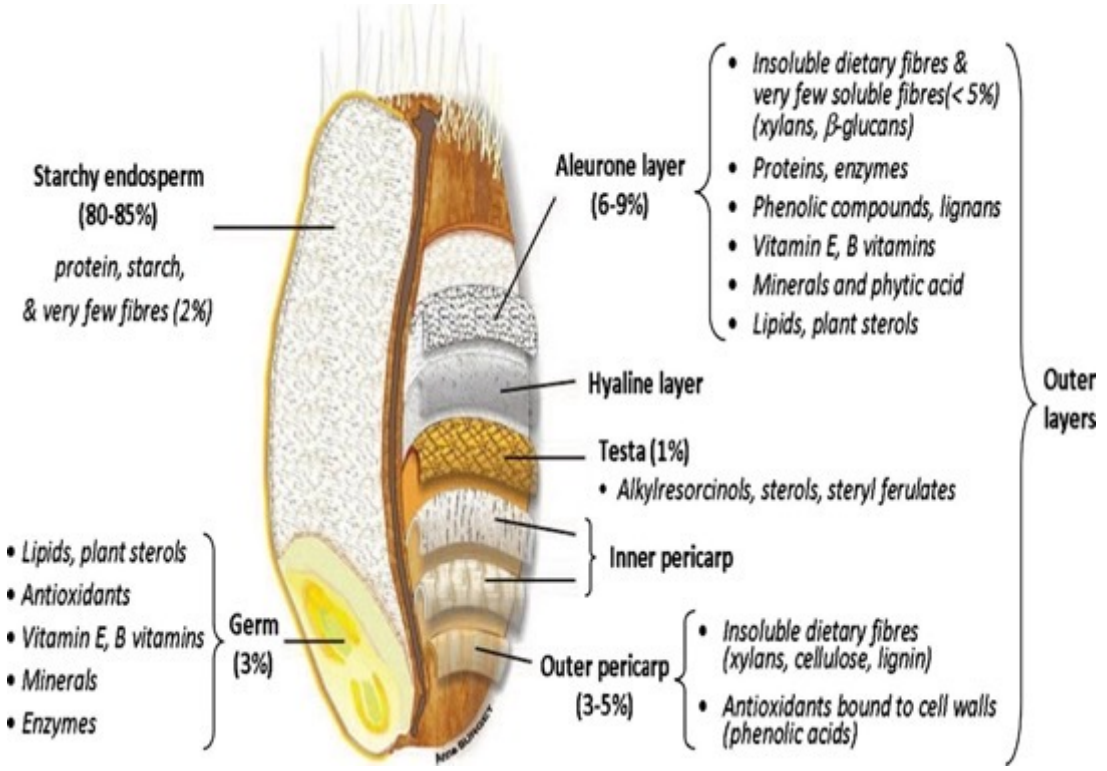


- Involves the separation of the endosperm from the bran and germ, followed by a gradual reduction in endosperm particle size
- Grinding is achieved on pairs of parallel, iron cylinder (rolls) rotating in opposite directions
- Wheat passes through a series of rolls accompanied by sifting between stages
- The roll surface can be smooth or corrugated with grooves to produce cutting or shearing action

BREAK AND REDUCTION OPERATION

- The Objectives of **Break roll system** is to cut open the wheat grain and scrap out carefully the endosperm from the bran pieces, without fragmenting them
- Break Rolls have fluted / corrugated surface
- The operation is carried out in 5-6 stages; the roll gap deceases gradually
- The objective of **Reduction roll system** is to reduce the endosperm into flour
- Reduction rolls are smooth; 6–12 milling stages, interspersed with sifting that removes the flour produced by the preceding grind
- The grinding action of the smooth roll reduces the endosperm to fine particle and at the same time leaves the bran pieces intact so that they can be separated in the sifter

RELATIONSHIP BETWEEN MILLED FRACTIONS AND NUTRITION



	Extraction rates						
	100 %	95%	91%	87%	80%	75%	66%
Ash	1.8	1.5	1.3	1.0	0.7	0.6	0.5
Protein (N x 6.25)	14.2	13.9	13.8	13.8	13.4	13.5	12.7
Fat	2.7	2.4	2.3	2.0	1.6	1.4	1.1
Starch plus sugar	69.9	73.2	75.3	77.2	80.8	82.9	84.0
Crude fiber	2.4	2.1	1.5	1.1	0.2	0.3	0.2
Dietary fiber	12.1	9.4	7.9	5.5	3.0	2.8	2.8
Energy, kJ/g	18.5	18.5	18.5	18.5	18.4	18.3	18.4

Significant loss of nutrients during the refining of wheat

***Source*: Slavin et al., (2000)**

RELATIONSHIP BETWEEN EXTRACTION AND ASH CONTENT

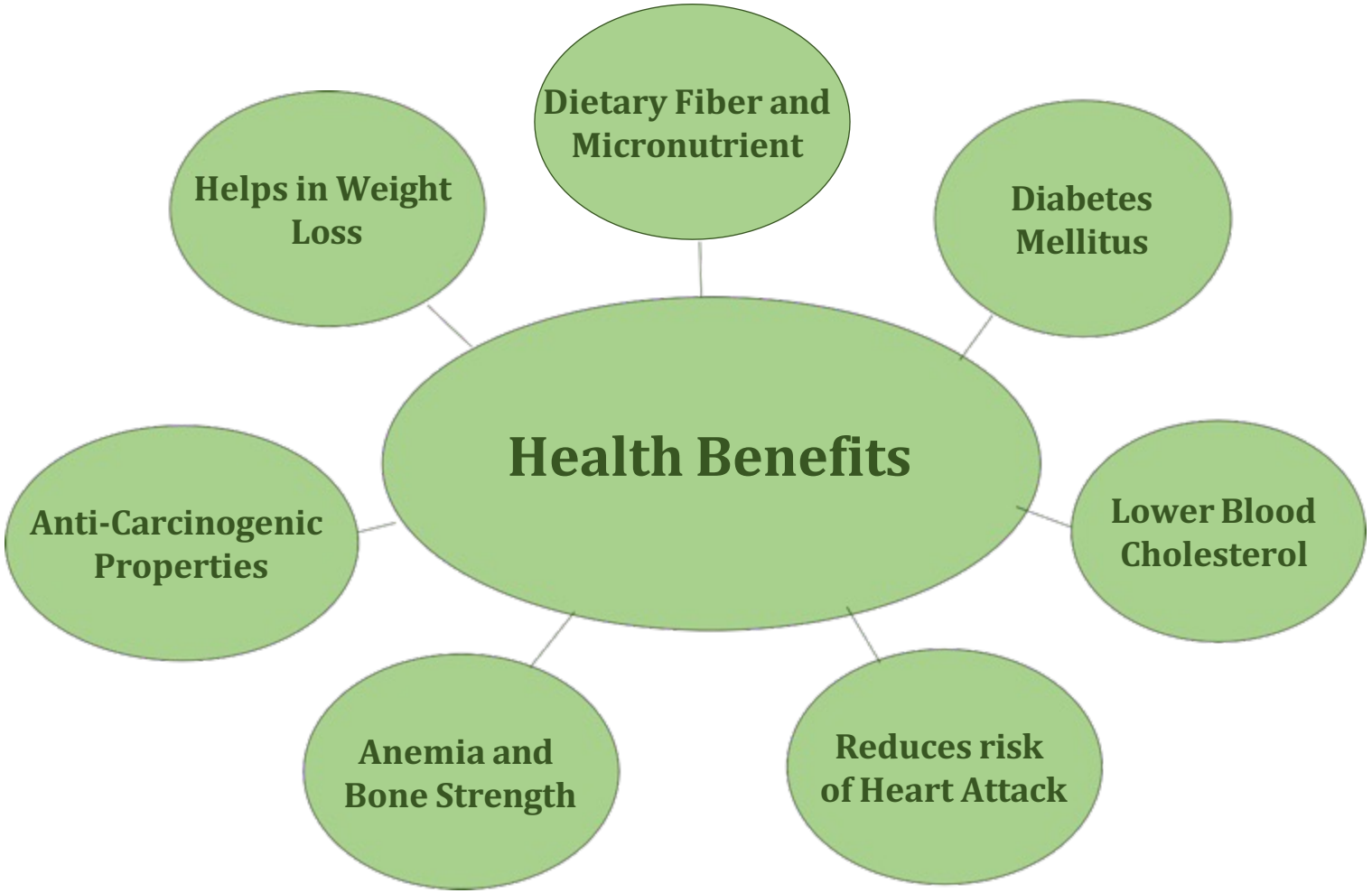
Flour Type	Extraction (%)	Ash Content (%)
Whole Wheat Flour (atta)	95-100	1.1-1.7
High Extraction Flour	80-95	0.75-1.10
Refined wheat Flour	75-80	0.55-0.75
Patent Flour	50-60	0.50
Top Patent Flour	45-50	0.40

WHOLE GRAINS & PROCESSING TECHNIQUES

Whole grains shall consist of intact, ground 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.

1. Minimally processed whole grains or milled: Grains kernel intact / minimally processed by flaking or cracking (Cracked wheat, flaked whole grain, steel cut oat etc.)
2. Whole grain flour produced by single stream or multiple stream milling with recombination

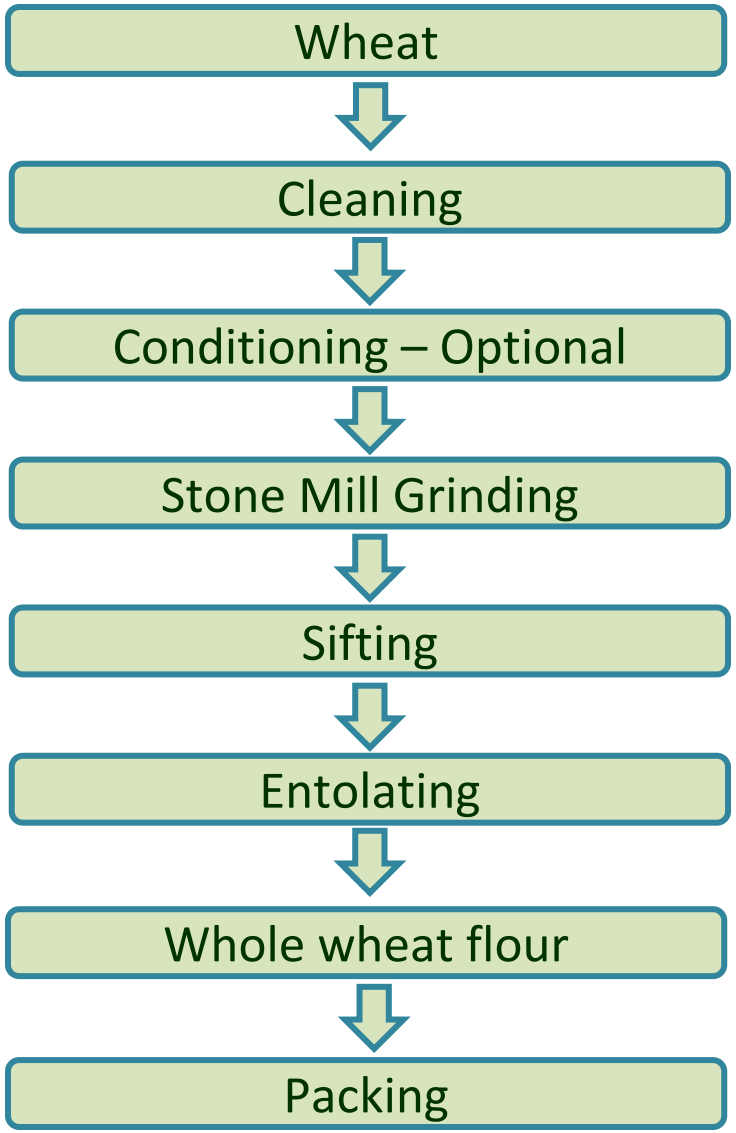
WHOLE GRAIN FLOUR- HEALTH BENEFITS



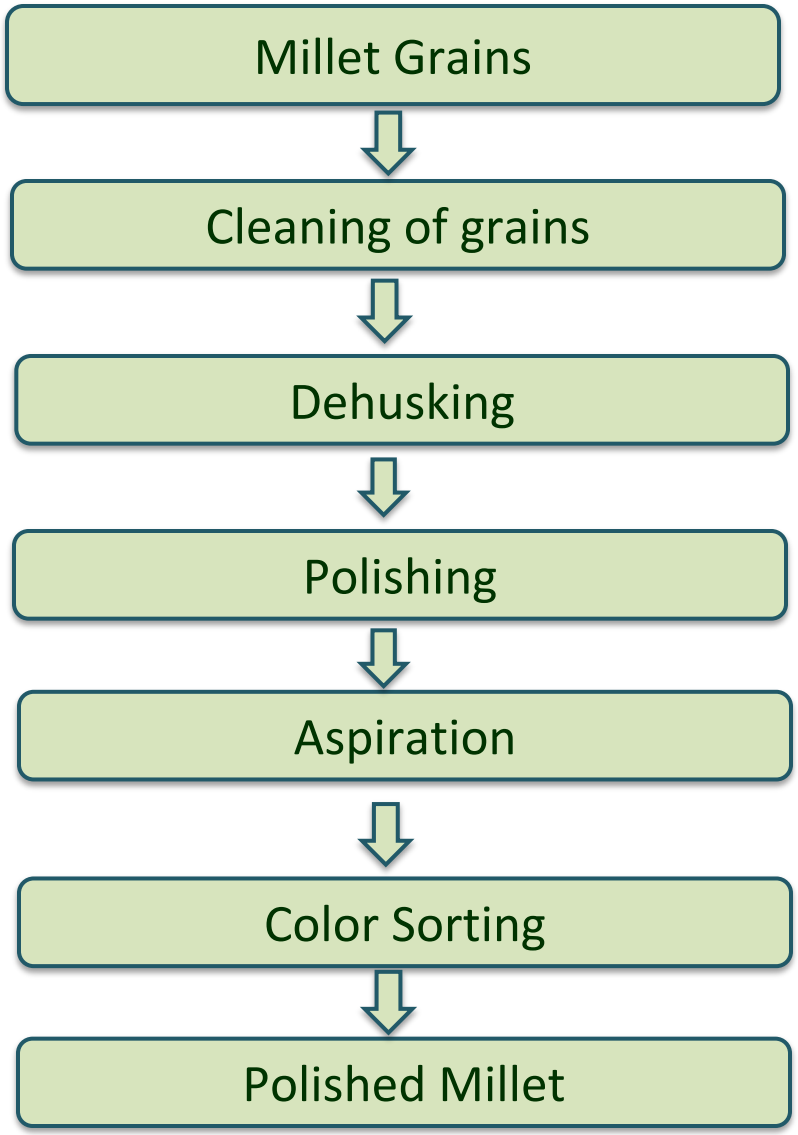
FLOUR PROPERTIES

WHOLE FLOUR	REFINED FLOUR
• Nutritionally superior • Higher levels of dietary fiber, protein, fat, and micronutrients • Mineral content is significantly greater • Color of stone-milled flours is darker • Shows a broader particle size distribution • Typically results in greater starch damage • Higher water absorption • Ideal for flour with high nutritional content and strong market appeal.	• Higher starch than stone-milled flour • Low in other nutrients-fiber, mineral • Exhibits superior rheological properties • Brighter color denotes milling efficiency • Can be ground to very fine particle size, due to absence of bran • Generates less heat during operation • Longer shelf life than whole grain stone-milled flour • Suited for large-scale production to meet industrial requirements

WHOLE WHEAT FLOUR DEVELOPMENT

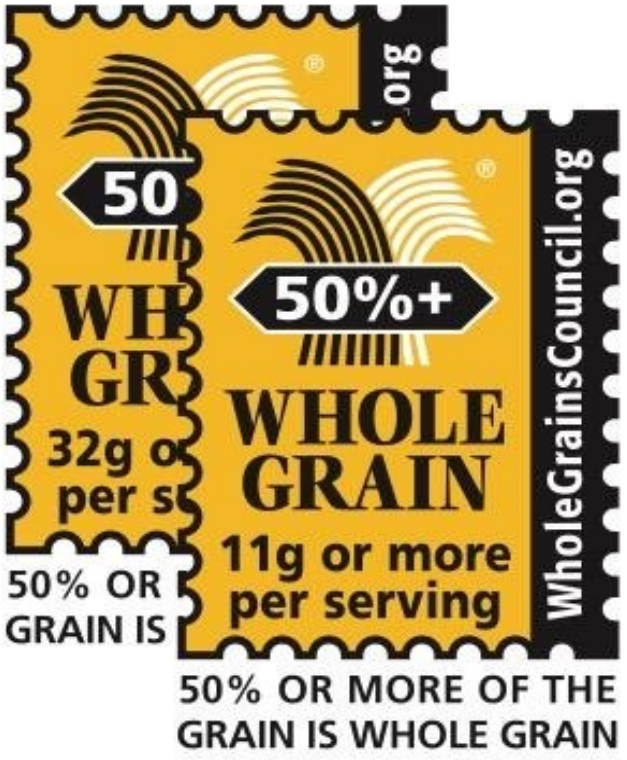


MILLET PROCESSING



WHOLE GRAIN STAMP

100% OF THE GRAIN IS WHOLE GRAIN



50% OR MORE OF THE GRAIN IS WHOLE GRAIN

EAT 48g OR MORE OF WHOLE GRAIN DAILY

Source: wholegrainscouncil.org

LABELLING

- whole grain/gluten free/ enriched or processed
- Date of production/ best by
- Pizza flour/ bread flour
- Pack size
- Ingredient list: first ingredient is the ingredient that is present in highest amount
- Nutrition label indicate daily value based on serving size
- Spec sheet indicates protein or fat level of flour

RESEARCH IN THE AREA

RESEARCH ARTICLE

Characterizing whole-wheat flours produced using a commercial stone mill, laboratory mills, and household single-stream flour mills

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Funding information
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Background and objectives: One hard wheat and one semi-hard wheat were milled on commercial, laboratory, and household-scale flour mills with rotating elements ranging from 0.1 to 1.0 m in diameter and speeds ranging from 65 to 40,000 rpm. The aim of the study was to assess and compare the quality of the flour from each of mills.

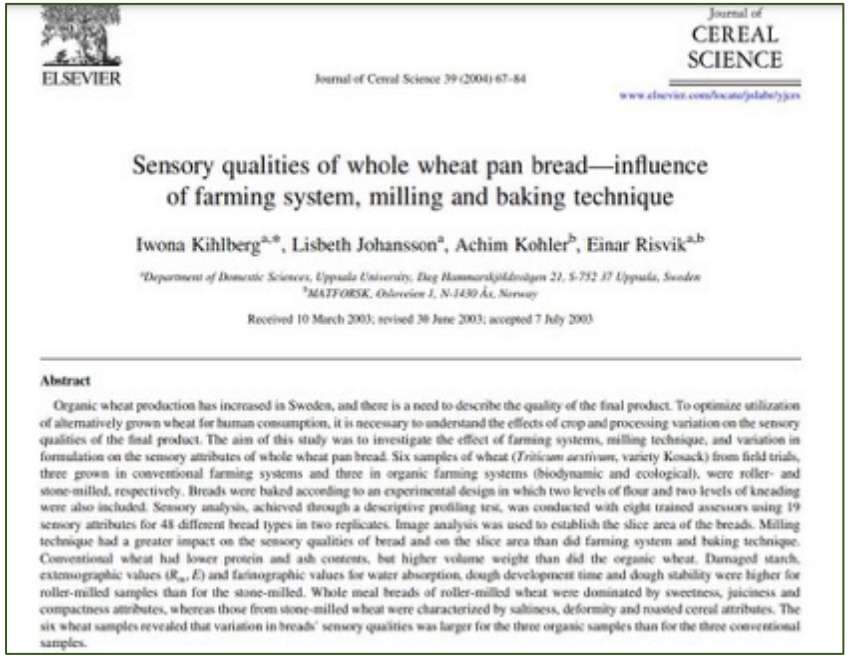
Findings: Pasting viscosities, Farinograph development time and stability, and loaf volumes (LVOL) were all markedly influenced by whole-wheat flour particle size, which differed markedly between mills. LVOLs were acceptable using the flours produced by all the mills. Best flour quality came from the three mills that produced the finest whole-wheat flour. Of these, the superior flour came from the 1.0-m-diameter Ottiroler stone mill. This mill produced whole-wheat flours with more optimal levels of starch damage and higher water absorption than did the smaller mills. There was no evidence of degradation of gluten functionality even at a flour temperature of 51°C.

Conclusions: The mill used affected almost all flour quality traits. However, the characteristics of the wheat applied to the mill were the dominant influence on flour functionality. Starch damage may better indicate milling severity than the heat generated during the milling process.

Significance and novelty: This is the only study, that we know of, on the comparative performance of household-scale flour mills. The study also presents an alternative way of visualizing particle size distributions of flours.

KEYWORDS
flour functionality, flour temperature, particle size distribution, stone mills, whole-wheat

Whole grain flour development using different mills, mill settings, pre-processing, flour quality and influence on end product



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Journal of Cereal Science 39 (2004) 67–84

Journal of CEREAL SCIENCE

www.elsevier.com/locate/jnlabr/yjcrs

Sensory qualities of whole wheat pan bread—influence of farming system, milling and baking technique

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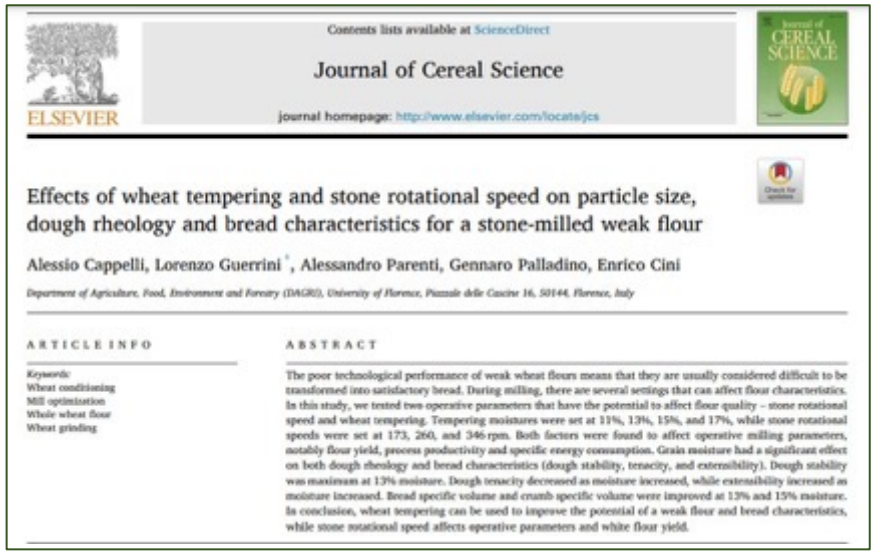
Received 10 March 2003; revised 30 June 2003; accepted 7 July 2003

Abstract

Organic wheat production has increased in Sweden, and there is a need to describe the quality of the final product. To optimize utilization of alternatively grown wheat for human consumption, it is necessary to understand the effects of crop and processing variation on the sensory qualities of the final product. The aim of this study was to investigate the effect of farming systems, milling technique, and variation in formulation on the sensory attributes of whole wheat pan bread. Six samples of wheat (*Triticum aestivum*, variety Kosack) from field trials, three grown in conventional farming systems and three in organic farming systems (biodynamic and ecological), were roller- and stone-milled, respectively. Breads were baked according to an experimental design in which two levels of flour and two levels of kneading were also included. Sensory analysis, achieved through a descriptive profiling test, was conducted with eight trained assessors using 19 sensory attributes for 48 different bread types in two replicates. Image analysis was used to establish the slice area of the breads. Milling technique had a greater impact on the sensory qualities of bread and on the slice area than did farming system and baking technique. Conventional wheat had lower protein and ash contents, but higher volume weight than did the organic wheat. Damaged starch, extensographic values (R_m, E) and farinographic values for water absorption, dough development time and dough stability were higher for roller-milled samples than for the stone-milled. Whole meal breads of roller-milled wheat were dominated by sweetness, juiciness and compactness attributes, whereas those from stone-milled wheat were characterized by saltiness, deformity and roasted cereal attributes. The six wheat samples revealed that variation in breads' sensory qualities was larger for the three organic samples than for the three conventional samples.



Contents lists available at ScienceDirect

Journal of Cereal Science

journal homepage: http://www.elsevier.com/locate/jcs

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Effects of wheat tempering and stone rotational speed on particle size, dough rheology and bread characteristics for a stone-milled weak flour

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ARTICLE INFO

Keywords:
Wheat conditioning
Mill optimization
Whole wheat flour
Wheat grinding

ABSTRACT

The poor technological performance of weak wheat flours means that they are usually considered difficult to be transformed into satisfactory bread. During milling, there are several settings that can affect flour characteristics. In this study, we tested two operative parameters that have the potential to affect flour quality – stone rotational speed and wheat tempering. Tempering moistures were set at 11%, 13%, 15%, and 17%, while stone rotational speeds were set at 173, 260, and 346 rpm. Both factors were found to affect operative milling parameters, notably flour yield, process productivity and specific energy consumption. Grain moisture had a significant effect on both dough rheology and bread characteristics (dough stability, tenacity, and extensibility). Dough stability was maximum at 13% moisture. Dough tenacity decreased as moisture increased, while extensibility increased as moisture increased. Bread specific volume and crumb specific volume were improved at 13% and 15% moisture. In conclusion, wheat tempering can be used to improve the potential of a weak flour and bread characteristics, while stone rotational speed affects operative parameters and white flour yield.

International Journal of Food Science and Technology 2004, **39**, 459–463

Short communication

Stones adjustment and the quality of stone-ground wheat flour

Pierre Gélinas,[1]* Karine Dessureault[1] & Robert Beauchemin[2]

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2 La Meunerie Milanaise, Milan, Quebec, Canada

(Received 30 December 2002; Accepted in revised form 29 August 2003)

Keywords Dough rheology, flour quality, milling.

RAW MATERIALS

SPRING WHEAT

EINKORN

PROSO

SORGHUM

DURUM

QUINOA

LENTIL

SPELT

EMMER

BUCKWHEAT

PINTO BEANS

OPPORTUNITIES

- ❖ Health and wellness market growth
- ❖ Increase demand of High Fiber Food Products
- ❖ Weight Management program
- ❖ Reduction in chances of life style diseases

- ✓ Spread the word-nutritional benefits
- ✓ Develop processing technologies- more research needed
- ✓ Extending shelf-life and storage
- ✓ whole grains inclusion into the regular diet require acceptable sensory parameters
- ✓ Food processing units can play critical role by providing solution

REFERENCES

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- Suo, T., Guo, X. N., & Zhu, K. X. (2022). Effects of tempering with plasma-activated water on total plate count and quality properties of wheat flour. *Journal of Cereal Science*, *105*, 103468.
- Whole Grain Stamp: https://wholegrainscouncil.org/whole-grain-stamp
- Northern Crops Institute. *Stone Milling Handbook*. 2023

QUESTIONS

!?!

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THANK YOU

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Interactive Informal Self Assessment

POLL: What does the ash content of wheat flour refer to?

A. Foodborne pathogen content

B. Mineral content

C. Fiber content

D. Fat content

POLL: Compared with milling methods that sift out the bran and germ, milling methods that retain the bran, germ, and endosperm in their original proportions have…

A. More fiber and more ash

B. More fiber and less ash

C. Less fiber and less ash

D. Comparable amounts of fiber and ash

POLL: Which of these statements is TRUE?

A. Stone milling is the only milling method to produce whole grain flour.

B. Stone milled flours have a lower water absorption.

C. Stone milling generates less heat than roller milling.

D. Stone milled flour and roller milled flour can both be either whole grain or refined, depending on if the resulting flour contains the bran, germ, and endosperm in its original proportions.