

A Study on the Core Issues in Wheat's Refining Processing

Xu Ke

Shijiazhuang Foreign Language Education School

This paper takes the wheat flour processing of Jinshahe Flour Manufacturing in Shahe, Hebei as an example. It analyzes the effort by the grain processing enterprises to reduce nutrient loss and food waste and provides suggestions to improve the production process as well as reducing loss and waste.

1. Introduction

Wheat is a gramineous plant and grain crop originating in Asia and has become one of the main carbohydrates source. There was a record of people eating wheat in Shang Dynasty 3000 years ago. Since then, wheat has been one of the most important food sources in China.

In recent years, due to the improvement of people's living standards and quality, healthy diet has been widely recognized in society. People focus more on food safety and quality, thus there is higher requirements for wheat processing, especially on the appearance indicators such as whiteness and brightness. Surprisingly, the changes in consumers' attitudes and mindset have contributed to a dilemma in China's wheat processing: on the one hand, consumers have demands for wheat flour in both nutrients' maintenance and its appearance. To promote product sales, manufacturers have to gradually increase the processing precision. This results in excessive processing. On the other hand, this refine processing leads to an astonishing waste of grain caused by excessive scraping and grinding. Studies show that China's grain waste in processing reaches 7.5 billion kilograms ^[1]. Waste can be found not only in wheat nutrients and even in wheat germ or endosperm during the processing. The main contradiction lies in the fact that embryos and seed coats that are rich in nutrients and fibers are extracted in flour processing to meet food demands.

2. Waste in Wheat's Processing

2.1 Nutrient Loss Resulting from Processing

Hebei Province is the main production area of wheat in China and has many wheat processing enterprises of different sizes. Traditional flour processing enterprises clean and sieve wheat, then transform it into flour with different grades, and separate wheat bran, germ and other by-products. Nowadays, Chinese consumers not only require wheat flour and other grains to provide the essential proteins and sugars, but also have higher expectations in appearance and taste. Consumers even further hope the products can be used as a health supplement. The level of wheat refining processing is negatively correlated with its nutrient composition. When bran and germ are removed in wheat processing, nutrients including protein, dietary fiber, minerals, trace elements, vitamins will be greatly reduced (see Figure 1-2). The removal of germ and wheat germ, seed coat and aleurone layer

lead to nutrient loss, leaving only protein and carbohydrate in wheat endosperm as well as few minerals and vitamins.

Nutritional Components Table of Wheat Flour of Different Grades (Content in per 100g of Food)					
	wheat	wheat bran	standard flour	special second-class flour	special first-class flour
heat (kilocalorie)	317	220	344	349	350
protein (gram)	11.9	15.8	11.2	10.4	10.3
fat (gram)	1.3	4	1.5	1.1	1.1
carbohydrate (gram)	64.4	30.1	71.5	74.3	74.6
dietary fiber (gram)	10.8	30.3	2.1	1.6	0.6
ash (%)	1.6	4.3	1.0	0.6	0.7
calcium (mg/100g)	34	206	31	30	27
phosphorus (mg/100g)	325	682	188	120	114
potassium (mg/100g)	289	862	190	124	128
magnesium (mg/100g)	4	382	50	48	32
iron (mg/100g)	5.1	9.9	3.5	3.0	2.7
zinc (mg/100g)	2.33	5.98	1.64	0.96	0.97
selenium (mg/100g)	4.05	7.12	5.36	6.01	6.88
vitamin B1 (mg/100g)	0.4	0.3	0.28	0.15	0.17
vitamin B2 (mg/100g)	0.1	0.3	0.08	0.11	0.06
nicotinic acid (mg/100g)	4	12.5	2	2	2
vitamin E (mg/100g)	1.82	4.47	1.80	1.25	0.73
vitamin A (microgram)	0	20	0	0	0
carotene (microgram)	1.6	4.3	1	0.6	0.7
retinol equivalent (microgram)	10	14.5	12.7	12	12.7

(An excerpt from Chinese Food Classification Table, 2004)

Figure 1-1 Nutritional Components Table of Wheat Flour of Different Grades

2.2 Current Wheat Processing Technology Resulting in Serious Waste

(1) Waste in wheat cleaning

In the view of production enterprises, wheat's appearance plays a larger role in the quality of flour and other by-products. Thus, wheat refinery first select high-quality raw wheat according to its surface color and odor, and then remove impurities and grading, water regulation and wheat blending, wheat cleaning, grinding, sieving and purifying as well as post-processing for purchased wheat. Smaller, damaged, immature and shriveled grain will be unreasonably cleaned up and taken as impurities in screening, air separation, specific gravity separation, selection, magnetic separation and color separation in removing impurities and grading. The six above processes of impurity removal and grading will produce waste to varying degrees.

(2) Waste in Wheat Flour Milling

The instability of wheat blending, and tempering is the main factor causing waste in wheat flour milling process. First, there are six types Chinese wheat: white hard wheat, white soft wheat, red hard wheat, red soft wheat, mixed hard wheat and mixed soft wheat. Refineries need to blend and process wheat according to bulk density, moisture, stable time and the volume of wet gluten so as to obtain flour of uniform quality. Secondly, to improve the flour yield and wheat flour precision, secondary water spraying technology of wheat tempering which can maintain uniform moisture, is very important. However, the production technology of most enterprises can not meet the requirements of uniform moisture. This leads to unstable product quality. After wheat being processed into flour, it is found that the stability duration and gluten index can not meet the requirements of downstream product purchasers, so these wheat processing enterprises can only produce flour of lower grade. In domestic wheat flour market, high quality lead to high price. This will inevitably result in a double waste of raw materials and finished products. Thirdly, regardless of wheat's post-ripening effect and in pursuit of high profits, many small-scale processing factories purchase newly acquired wheat at low prices and directly process and use it. Due to the immaturity of wheat before post-ripening, the processed flour cannot meet the requirements of the local market and can only be used in flour blending. This causes a double waste of raw grain and finished grain.

This phenomenon can be seen in the small-scale flour processing enterprises in Handan and Xingtai of China. Although these two places are located in China's high-quality wheat producing areas, locally processed wheat flour still cannot meet the market requirements due to backward technology and cost control, which results in a great waste.

3. Achievements Made by Jinshahe Group in Improvement of Production Technology

Hebei Jinsha Group, as one of the top 50 wheat flour processing enterprises in China, minimizes nutrition loss and food waste by improving conditioning and grinding.

3.1 Application of Wheat Tempering Technology with Uniform Moisture

To ensure the quality of flour, Jinshahe Group uses automated equipment facilities which can control wheat moisture and proportion for various purposes. It mixes and processes wheat according to bulk density, moisture and stable time to obtain flour with uniform quality. Aiming to improve flour yield and wheat flour precision, a secondary water spraying technology of wheat tempering, which can maintain uniform moisture, is adopted to make wheat more suitable for processing. This can also reduce the amount of bran, make the wheat flour stable in quality and excellent in all kinds of indexes. At the same time, the stable time can be differentiated so as to customize the production of various kinds of special flour, such as wheat with stable time of about 8 minutes for general flour, and wheat with stable time of 3-5 minutes for flour of fermented food such as bread. This can not only ensure the quality of wheat flour, but also better avoid waste caused by technology.

3.2 Light Grinding Technology Being Adopted

To reduce nutrition loss and damages to wheat, Hebei Jinshahe Group uses light grinding instead of traditional way of wheat milling, to lengthen mill flow and increase the amount of grinding as well as reduce the intensity of one-time grinding. With the temperature below 38 degrees, the nutrient loss will be minimized by controlling the flow and flour yield of break mill and reduction mill (see Figure 3-1).

	standard flour	graded flour
total average unit quantity of general mill	150-200kg/cm·24h	80-100kg/cm·24h
total average unit flow of plansifter	1500kg/m ² ·24h	1250-1600kg/m ² ·24h
flour yield of break mill system	45-60%	10-20%

Figure 2-1 comparison between standard flour and graded flour

4. Waste and Reuse of Wheat By-products

4.1 Waste of By-products

Generally speaking, wheat processing mainly involves flour, bran, germ, and secondary flour. For most flour processing enterprises, the profit mainly come from by-products and the by-products yield usually reaches 15-25 percent. Due to incomplete scraping of wheat in processing, part of wheat endosperm will be lost in secondary flour and bran, which will cause certain waste.

4.2 Reuse of By-products

The by-products of wheat are other products besides flour produced in the flour processing. But their nutrition is not lower than wheat flour. Wheat germ is rich in vitamin E, vitamin B and protein.

It also contains calcium, potassium, magnesium, iron, zinc, chromium, selenium, phosphorus, manganese, copper and other minerals as well as trace elements. Its nutritional value is very high.

The protein content of wheat bran is about 15 percent. It plays an important role in maintaining the balance of dietary nutrition. It is also a kind of high-quality raw material for preparing xylo-oligosaccharides. At the same time, its epidermis can also be used to produce active protein peptide of wheat bran, which is a good additive to improve food sensory.

Therefore, the application of by-products is a good means and method to improve the value of wheat, which can greatly increase its utilization rate. However, it is noteworthy that from food safety and wheat products standpoints, wheat bran and secondary flour cannot be directly edible or added. But with improved technology, germ extraction and whole wheat flour extracted from appropriate amount of bran, waste can be avoided, and the nutritional composition of wheat flour can be greatly improved.

5. Systematic Solutions to Waste and Loss of Wheat in China Being Needed

Wheat in China has a long processing chain and can be processed into more than 3000 industrial products [2]. Moreover, from wheat to food, it involves harvest, sales, storage, transportation, processing and consumption. The grain loss rate of rural storage itself is as high as 6-9 percent (see Figure 4-1). The detailed information is as follows: 1. incomplete harvesting of wheat, 2. loss in harvest, storage and transportation, 3. loss in processing, 4. consumption loss in making products.

	loss in harvest	loss in sales	loss in rural storage	loss in treasury storage	loss in transportation	loss in processing	loss in consumption	total
loss rate	4.9%	0.325%	6-9%	1-2%	0.725%	3.75%	6.3%	23-27%

Figure 3-1 loss rate of grain in every link

In summary, it can be seen that processing alone cannot solve all the problems of loss and waste, and a package of solutions based on China's national conditions needs to be found. To this end, the following suggestions are made:

5.1 Alleviation of loss and waste should be solved from the source of the grain market firstly.

Through various channels of publicity, people can attach much weight to the importance of nutrition, know about the composition and source of nutrition, and understand the importance of whole wheat flour. Government, research institutes and enterprises should work together to explore and promote the whole wheat flour technology and the research of related products.

5.2 Enterprises should improve processing technology and equipment to meet market demands.

The example of Hebei Jinshahe Group shows that adopting the most advanced production equipment and technology at home and abroad can minimize the nutrition loss and food waste.

5.3 Government and various industrial organizations should take specific measures to solve the problems.

Government can subsidize manufactures in technology research and equipment acquisition to speed up equipment renewal as well as the research and development of new technology. Scientific research institutes and trade associations can strengthen cooperation with production enterprises through personnel training and technology research, so as to provide talents and technical services for enterprises.

5.4 Wheat and its ancillary products can be made full use of. The development and utilization of wheat ancillary products should be strengthened not only in food and nutritional structure but also in various industries, such as fine processing of sugar and additive.

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Author's address: Shijiazhuang Foreign Language Education School

Shijiazhuang City
Hebei Province, PR of China

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