2015 marks 100 years of AACC International members working together to share cereal grain science. The Centennial Committee, with the help of many expert members, is creating activities to celebrate achievements and look to the future of our science. The Scientific Milestones Sub-committee is coordinating a series of summary highlights—each focusing on an important area of cereal grain science. Experts in each area have identified key breakthroughs over the last 100 years, provided brief descriptions of the discoveries, and given examples of how these breakthroughs led to changes in our cereal foods. The experts also provide a few ideas on where future research may lead us. These brief highlights are meant to provide an overview and cannot be inclusive of the exhaustive research in these areas.

Centennial Scientific Milestones Sub-committee: Lauren Brewer, Rachel Prososki, and Steven Nelson.

A Century of Advances in Milling and Baking

Elieser S. Posner and R. Carl Hoseney

MILLING

Major Developments in the Flour Milling Industry During the Last Century

The primary objectives of flour milling, to achieve maximum flour extraction with the best quality from different types of available wheat, have not changed throughout the last century. On the other hand, significant changes have occurred in machinery construction, auxiliary equipment, mill flow, and process control instrumentation. During the first half of the 20th century, the equipment and technology used in wheat flour milling developed independently on both sides of the Atlantic Ocean. Following World War II, improvements in travel, development of professional publications, and professional meetings led to a mutual exchange of ideas that resulted in the formation of similar trends. Many changes occurred simultaneously in equipment, auxiliary systems, and processing methods. Accordingly, descriptions will be concentrated on equipment and methods individually.

In 1870 there were 22,573 flour mills in the United States. By 2010 there were 170 operating mills in the United States, of which 68 had a daily milling capacity equal to or greater than 454 metric tons of wheat/day (Miller 2010). Currently, the total amount of wheat processed in the United States is about 80,000 metric tons/day. There are currently 45 companies in the milling business in the United States—the largest of which is the Ardent Company, which controls 34% of the U.S. flour market. The trend around the world is construction of larger capacity milling units that are situated at the most economical and convenient reception points for raw materials and distribution of final products.

Key Developments

At the turn of the 20th century, mills started to changeover from water-driven power to electrical motors. The Pillsbury "A" mill used water power until 1955 (Ferrel 1996), when water power was replaced by single electrical motors that, together with belt and shafts, were used to drive the whole mill. During the 1970s individual motors used to drive single machines were widely adopted to accommodate advances in mill automation.

Abraham Ganz developed the first roll stand in Hungary, which utilized horizontal rolls, at the end of the 19th century (Willm 2006). At the turn of the 20th century, millstones were still used in some countries for grinding wheat. The roll stand was incorporated slowly into the milling process—first with one pair of rolls and since the early 1920s with two pair of rolls in one machine. Around 1925 European mill engineering companies set the rolls in the machine diagonally, claiming more efficient

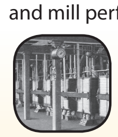
1900 Water driven mill

Early 1900s Baker's yeast isolated and produced commercially

1920s New milling and baking equipment powered by electricity developed as part of the Technological Revolution

1928 A machine to slice and wrap bread (invented by Otto Rohwedder) was first used commercially

1930s & 1940s Plansifters and sieves improved sifter capacity and mill performance



1942 First pneumatic conveying system constructed by Daverio grinding and space saving. In contrast, North American mills ran heavily casted machines with horizontally positioned rolls. North American roll stands ran at a speed of up to 525 rpm, using independent belts for their fast and slow rolls to accommodate the differential. At the same time, the Europeans were still running their rolls at a maximum speed of 420 rpm, using gears or chains to establish the differentials between the rolls. During the 1950s mill engineering companies and existing mills started the changeover from phosphor bronze to roller bearings in the machines. In addition, special timing belts began to be used to accommodate the differentials between the rolls. In Europe these developments allowed an increase in roll speed from about 420 rpm to 570–600 rpm. During the second half of the 1970s European mill engineering companies began constructing roll stands with horizontally positioned rolls. For better and for worse, the 1990s saw another development in roll stand construction with the manufacturing of double-high machines with four pairs of rolls in one machine.

The changes in roll stand construction allowed for increased speed and significantly reduced specific roll surface in mills. During the 1920s specific roll surface was about 63.26 mm/100 kg/24 hr (Miag 1936). European mills constructed in the 1950s had a specific roll surface of about 57 mm/100 kg/24 hr. During the 1960s specific roll surface was reduced to 35 mm/100 kg/24 hr. Currently, roll surface in operating mills is about 10–13 mm/100 kg/24 hr.

Sieving machines used in the milling process also have changed significantly over the last century. Smith (1940) described flour mill diagrams with reels, which were used up to the 1930s in mills around Europe. Smith (1940) also described the free-swinging type of plansifters that became popular in Europe, replacing the scalpers or reels in the mill diagram. European mill engineering companies constructed plansifters with elongated sieves that were cleaned with brushes and impellers (Lockwood 1945). North American mills were already using wooden sifters with square sieves (Marshall 1931). During the early 1960s the Europeans also started to manufacture and use sifters with square sieves.

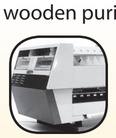
Developments in the bolting cloth used in flour milling occurred as well (Anonymous 2005). During the late 1940s synthetic bolting cloth started to replace natural silk cloth. The change in sifting media resulted in a significant increase in sifter capacity and improved mill performance.

The mill purifier is one of the main machines utilized in the milling process. Paur (1810) invented the first purifier, which was constructed by a cabinetmaker named Winter in the United Kingdom. In 1871 La Croix in America combined a purifier operating with sieves and air (Smith 1950). Toward the end of the 1940s European mill engineering companies started to manufacture a multiple-sieve purifier (Scott 1951), while in the United States single-sieve machines were manufactured. Initially purifiers were constructed from wood; during the 1950s metal purifiers were introduced on the market.

Standardization of milling products took different paths in Europe and North America. Bailey (1925) reviewed the literature on flour ash content as an index to flour grade and quality. Sherwood and Bailey (1928) showed a function of the relationship between wheat and flour ash. They stated that the ash content of the endosperm varies with the ash content of the entire kernel; this concept later received renewed interest in mill performance and adjustment (Posner 1991). In Europe Mohs (1934) developed a table based on numerous samples, giving the relationship between different levels of extraction and flour ash. Mohs based the table on some constants: 1.904% wheat ash, 3% screenings, 16% wheat to first break, and 14.5% flour moisture. In some parts of the world the Mohs' ash curve is still used to evaluate mill performance, regardless of the wheat mixes being used.

The first negative pneumatic conveying system designed to handle all the intermediate stocks in the mill was constructed by the Swiss mill engineering company Daverio in 1942 (Hopf 1950). Pneumatic systems replaced bucket elevators and a significant number of screw conveyors previously used in mills for transferring intermediate stocks. The pneumatic transport converted the milling system to a more hygienic operation. In addition, Bolling (1981) estimated an increase of about 5–7 kWhr/ton when changing from bucket elevators to pneumatic systems in the mill.

1950s Metal purifiers replaced wooden purifiers



1970s Electronics and multiple sensors incorporated in the milling system for additional control

Late 1900s Advances in enzyme technology allowed bakers to expand applications and maintain "clean" labels

2000 Wheat debranning prior to milling implemented

2010 NIR focal plane array chemical imaging of mill streams on-line introduced

Hygiene in the milling industry is an ongoing issue. Significant improvements were made in the 1950s when mill engineering companies started to design and manufacture equipment with hygiene in mind. There was also a change in material handling in the mill. Negative and positive pneumatic systems replaced bucket elevators, and metal pipes replaced wooden spouting for gravity flow.

1960

During the 1960s the first steps in implementing near-infrared (NIR) spectral absorption properties were used to evaluate grain moisture and protein content. The resulting spectra were interpreted in terms of absorptions from O-H and C-H stretching vibrations. (Hart et al. 1962; Ben-Gera and Norris 1968). NIR allows on-line evaluation of mill intermediate material characteristics and means to control and adjust mill performance (Posner and Wetzel 1986).

Automation of the wheat milling process changed significantly during the last century. As early as 1791 Oliver Evans was able to convert the milling operation to an automatic process using screw conveyors and bucket elevators. Evans was granted U.S. Patent No. 3 for the Mount Vernon automated mill. Since Evans, the professional miller has been involved in adjustment and control of the loads to all stages in the process to achieve a balanced and fully automated process. Starting in the 1970s electronics and multiple kinds of sensors were incorporated in the milling system for additional control. Automation initiated the changeover from one motor driven mill or several to an individually driven machine. Mill automation resulted in an average increase in energy requirements from 55 kWhr/ton to more than 80 kWhr/ton of wheat processed.

1970

Around the beginning of the 21st century a long contemplated idea for wheat kernel bran removal prior to the milling process was implemented in commercial mills with significant success (Gregory 2008).

Wetzel et al. (2010) suggested an approach to allow evaluation of mill streams, process adjustment, and fine-tuning of the mill diagram. With the use of InSb focal plane array chemical imaging, chemical images with 82,000 pixels of each intermediate product stream issuing from an individual processing machine are readily analyzed in terms of the relative amount of endosperm and nonendosperm content.

Present Day Challenges

New wheat varieties, changes in climate, and diversification of wheat sources demand continuous study of mill process parameters and necessary adjustments. All the advances in equipment made during the last century did not replace the professional miller's need to study and thoroughly know all the intermediate stock characteristics in the mill. This knowledge allows for the proper adjustment of the process and equipment needed to produce the desired final products. Optimal performance starts with identification of the raw material characteristics. Geddes et al. (1933) suggested an approach for wheat evaluation before commercial milling. The milling process and resulting products are affected by wheat physical characteristics such as kernel size distribution, thousand kernel weight, hardness, and shape. To date, none of the commercial wheat grading systems include these parameters. Today, similar equipment for processing wheat is used around the world, and many methods of wheat evaluation are known (Shellenberger 1955). However, there are still no acceptable internationally standardized grading procedures for appraisal of wheat quality for processing into flour.

BAKING

Baking in the 20th Century

Baking has undergone immense changes during the 20th century. At the turn of the century most baked goods were made at home. Commercial operations were, for the most part, small shops that used hand labor. Much of the bread production utilized a sourdough process in which leavening was accomplished through a combination of bacteria and wild yeast. This process required that part of each day's production of dough be retained to serve as a starter (inoculum) for the next day's production. This process had both positive and negative aspects. On the positive side, each shop had it own starter, so each had its own unique bread flavor. On the negative side, daily production was limited by the amount of starter available. If you ran out of starter, you were done baking until the next day. Because it was a "wild" fermentation process, output varied from day to day depending on the weather and other variables. Thus, it was impossible to set a firm production schedule.

Development of Baker's Yeast

In the 19th century the yeast used by bakers was obtained from brewers. In the brewing process yeast multiplies and, thus, is a by-product of brewing. However, yeast selected for brewing did not have the properties (primarily rapid gas production) needed for baking. Both baker's and brewer's yeasts are *Saccharomyces cerevisiae* species, but are different strains. In the early 20th century, advances in microbiology enabled a yeast strain suited for baking to be isolated and gave rise to an industry centered on producing yeast for the baking industry. This product was sold as compressed yeast that had to be refrigerated and gave the baking industry a reliable source of yeast that essentially guaranteed a reproducible fermentation.

1980

During the last 100 years a number of changes and improvements have been developed for yeast production. Active dry yeast was developed for the armed services during World War II. In a sealed pouch, it has a shelf life of one year, and when properly rehydrated, it has reproducible activity. This form was readily available commercially in supermarkets for home bakers. In the 1970s instant dry yeast was developed that could be mixed with flour and used with no prehydration. This form of yeast had greater activity than active dry yeast and replaced it for many applications. In the 1990s, large commercial bakeries switched to cream yeast for bread production. Cream yeast is the same as compressed yeast, but sufficient water is added to make a slurry. This slurry is stored in refrigerated tanks, so the yeast can be pumped and metered into dough mixers. This made it much easier to handle and also produced more stable yeast than when compressed in blocks. In general, cream yeast is not available for small shops or home bakers.

Development of Chemical Leavening

During the 19th century sweet goods (cookies, cakes, etc.) were produced mainly in the home or small shops. The baked sweet goods available were limited by the leavening agents bakers had at hand. These were essentially air or ammonium bicarbonate.

Although air is ubiquitous as a leavening agent, it does not by itself give a light product. Generally, air-leavened products tend to be heavy and dense. Ammonium bicarbonate was available, but was limited to use in products that do not retain much moisture. If products retain moisture, they also retain the ammonia that is one of the breakdown products of ammonium bicarbonate. The odor of ammonia is not compatible with good baked products. Thus, ammonium bicarbonate is a good leavening agent for cookies that are baked to near dryness (2–3% moisture content), but it has serious limitations in moist products.

Many of the problems with leavening sweet goods were solved with the invention of baking powder. Baking powder was invented in the late 19th century and came into wide use early in the 20th century. Baking powder is a mixture of soda (sodium bicarbonate) and one or more acidic salts together with a dry, inert powder (usually dried starch). The starch is used to keep the two reacts (soda and acid) apart. Baking powder can be single or double acting. In the case of single-acting baking powder (soda plus one acid), the acid is usually soluble in water, and thus, the leavening action is triggered as soon as water is added. Double-acting baking powder systems contain two acids: generally one that is readily soluble and one that has more limited solubility. The less soluble acid often requires heating of the product in an oven to solubilize and trigger leavening. The advent of various baking powders gave the baker tools to produce a wide variety of sweet goods.

Effects of the Second Industrial Revolution

The biggest event to bring baking out of the home and small shop was the Second Industrial Revolution or Technological Revolution (ca. 1860–1920). This era brought, among other things, the availability of economical electrical power. The availability of inexpensive electrical power led to the development of machines that could carry out the functions of baking without the use of excessive hand labor. These included dough mixers, molders, dividers, proofing cabinets, etc. Important in this was the development of ovens generally fired with natural gas, which replaced the wood- and coal-fired ovens used in the 19th century. Also developed were long (300 feet) tunnel ovens (Fig. 1) with traveling belts powered by electricity.

Over the last 100 years the machines used in bakeries have been improved and made larger and more efficient, but the basic functions of the machines have not changed. Sweet good bakeries have undergone similar changes. Some of the equipment is similar to that found in the bread plant; however, many pieces of very specialized equipment have been developed to make the cookies, crackers, or cakes a plant produces.

Fig. 1. Baked product exiting a tunnel oven.

Baking Procedures Used During the 20th Century

A number of baking procedures have been used during the 20th century to produce commercial breads. At the start of the century a straight-dough procedure was by far the most popular (Fig. 2). In this procedure all the formula ingredients are added to the mixer at the start, and the dough is developed. After mixing, the dough is allowed to ferment for up to 3 hr. During fermentation the dough is punched at intervals; generally the intervals correspond to the dough increasing its volume by a factor of 2. A typical punching schedule might be after 105 min, 55 min, and 35 min. Thus, it is clear that the rate of fermentation increases with time. After fermentation the dough is divided into loaf size pieces and given a rest time (often called an intermediate proof) of 10–15 min. This allows the dough to rest or relax so it can be worked in the next step without damage. The next step involves molding to form the dough into a log shape that is then placed in the baking pan. The baking pan containing the dough is placed in a proofer for an hour or longer to allow the dough to proof. After proofing, the pan and dough are placed in the oven for baking. The straight-dough procedure produces bread that is strong (chewy) and somewhat tough. To produce consistent bread using the procedure the timing of the various steps must be carefully controlled. Thus, the procedure demands the use of smaller batches, because large batches have a longer processing time. For example, when processing a large dough the loaves from the start of the dough have a much shorter processing time than those from the end of the dough.

A number of other baking procedures were also used during the 20th century, the most popular of which was the sponge-and-dough procedure (Fig. 3). In this procedure, part of the

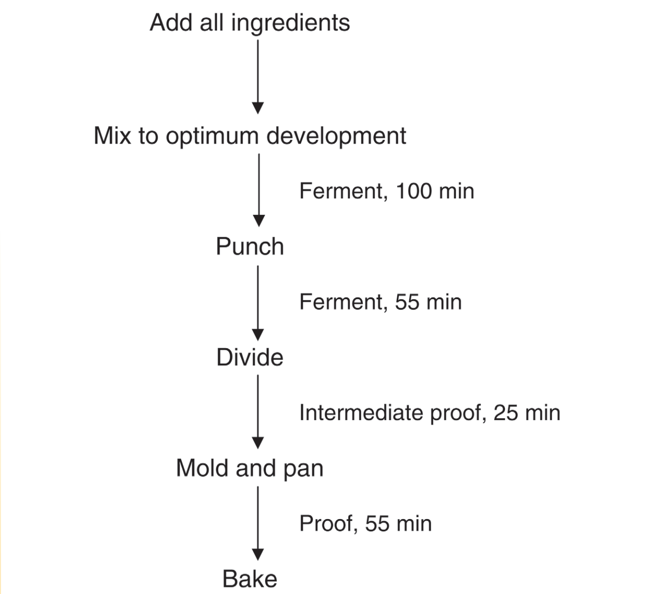


Fig. 2. Outline of a straight-dough procedure. (Reprinted with permission from Delcour and Hoseney, Page 182 in: *Principles of Cereal Science and Technology*, 3rd ed. AACC International, 2010)

flour (about 1/3) is mixed with water, yeast, salt, etc. into a loose dough (the sponge) and allowed to ferment for 3–5 hr. At the end of the sponge time, the remaining formula ingredients, including the remaining flour, are added, and the total is mixed to full dough development. After a short rest time (≈15 min), the dough is divided into loaf size pieces and processed as described above for the straight-dough procedure. The sponge-and-dough procedure gives a softer bread that is often perceived to have a better flavor. The procedure also has a greater tolerance to variation in processing time.

Another procedure used to produce bread is a no-time dough procedure that, of course, is not produced in no time. The "no time" refers to no specific fermentation time. Cutting out the fermentation time or reducing it to a few minutes saves considerable time and allows for flexibility in production schedules. The bread produced tends to be less chewy and is often considered to have less flavor. No-time dough procedures appear to be very useful for frozen dough applications and increased in popularity later in the century.

In the 1950s continuous breadmaking systems became popular. The dough was given a high-speed mix and extruded directly into the baking pan. After proofing, the bread was baked. This type of system saves considerable time and, thus, is an economically favorable system for producing bread. The bread crumb produced is very weak and, since it is not molded, is extremely uniform. One can identify continuous bread based on its uniform and small cell structure compared with bread produced using a sponge-and-dough procedure (Fig. 4). At one point continuous breadmaking systems were responsible for as much as 40% of U.S. bread production. Since it was economical to produce, the bread was sold at a lower price compared with sponge-and-dough breads. However, the public did not continue to buy these breads, and continuous breadmaking systems slowly decreased in importance as a breadmaking procedure. More successful have been other short-time baking procedures, such as that developed in England (Chorleywood procedure) and somewhat similar systems in Australia and New Zealand. These procedures have been more successful, or at least they have lasted much longer, than the U.S. system.

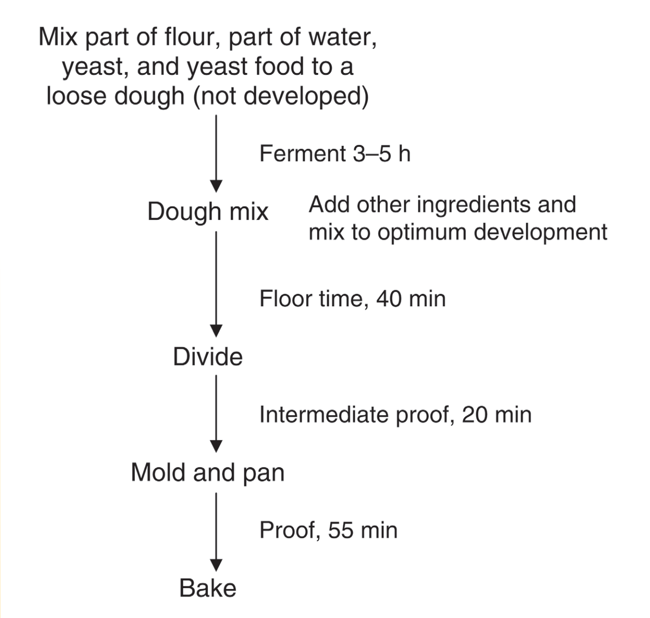


Fig. 3. Outline of a sponge-and-dough procedure. (Reprinted with permission from Delcour and Hoseney, Page 182 in: *Principles of Cereal Science and Technology*, 3rd ed. AACC International, 2010)

Supplemental Ingredients Used in Bread Formulas

In addition to the required flour, water, yeast, and salt there are a number of ingredients that are usually found in bread formulas. These include sugar, fat, and, sometimes, dried milk powder. The sugar used has traditionally been sucrose (table sugar). Today, high-fructose corn syrup is also widely used. Since yeast elaborates an invertase enzyme that rapidly converts sucrose into equal parts glucose and fructose, it appears there would be no difference between using sucrose or high-fructose corn syrup, which also has essentially equal amounts of glucose and fructose, as a source of food for the yeast. In most long-fermentation bread procedures, about 3% sugar is consumed by the yeast. In short-time systems, somewhat less sugar is consumed. Since sugar is added in the formula at about 8–10%, most of the sugar remains in the bread to impart sweetness.

At the start of the 20th century the fats available to the baker were primarily animal fats, and lard was commonly used. As the chemistry of fats was developed and more vegetable fats became available, bakers moved to using the less flavored and more flexible vegetable fats. Part of this change was based on the function of the fat in baking and part of the change was because of health concerns associated with animal fats. In the middle of the 20th century, milk was abundant, and the health benefits of milk were well known. Thus, bakers added nonfat dried milk to their formulas. Milk had some processing benefits, and it certainly looked good on the ingredient label. Later in the century, milk become more expensive, and most nonfat dried milk disappeared from the formula. Today, the milk product found in bread formulas is usually whey in combination with soy protein.

Based on the work performed with fats, surfactants were developed. Starting with monoglycerides, surfactants were shown to be effective as antistaling agents. In addition, many surfactants were found to have dough-strengthening effects, and some improved bread loaf volume. Thus, they became popular as formula ingredients.

Wheat flour naturally contains enzymes, among these are α- and β-amylase. These enzymes are known to improve staling, soften the crumb, and improve the overall quality of the bread. The problem with native enzymes is that enzyme activity varies widely from one sample to another. Thus, the practice of adding

Fig. 4. Crumb grain of bread produced by the continuous baking procedure (left) and a sponge-and-dough procedure (right). (Reprinted from Hoseney and Seib, *Cereal Foods World* 23:362, 1978)

malted barley or wheat flour (a source of enzymes, including α- and β-amylase) to the bread formula was common in the early part of the 20th century. By the end of the century, great strides were being made in the development of enzyme technology, particularly in the use of genetic engineering to produce pure enzymes. This has led to the use of many enzymes in baking formulas. Another reason for the adoption of enzymes was the fact that they did not have to appear on the ingredient label because they are denatured during the baking process. Thus, the use of enzymes allows the baker to produce a cleaner label. Most bread produced today contains several enzymes. Particularly effective are those that slow staling.

Baked Product Trends

Sliced Bread. We have all heard the expression that something is the greatest thing "since sliced bread." A machine to slice and wrap bread was invented by Otto Rohwedder and first used commercially in 1928. By 1933 nearly 80% of the bread sold in the United States was sliced and wrapped (Fig. 5).

Tortillas. During the last few decades of the 20th century wheat flour tortillas were the fastest growing bakery product category in the United States. The flat bread production rate has risen from essentially none to be the second largest baking category, behind only sliced white bread. Its increasing popularity shows no signs of slowing down as we move into the 21st century. The formula for wheat flour tortillas can be simple: flour, shortening, salt, and water. Two processing methods are used to produce wheat flour tortillas. In one, the dough is sheeted to the desired thickness, and the tortilla is cut from the dough sheet. In the second procedure, the dough is formed into a ball and hot-pressed to produce the tortilla. In both cases, the tortillas are baked in a specialized triple-pass oven. Some tortillas are stored and sold at room temperature; others are stored and sold refrigerated.

Other than the machine developed to make and package cookies and crackers, the industry has changed slowly over the last century. The exception to this is the large number of snack crackers that were developed in the 1980s.

Fig. 5. Bread loaf sliced with an automated bread slicer.

References (Milling)

Allis-Chalmers Manufacturing Co. *Flour Mill Price Book No. 2*. The Company, West Allis, WI, 1921.

Anonymous. 175 Yahr Sefar—Eine unendliche Geschichte. Muehle + Mischfutter 142:820, 2005.

Bailey, C. H. *The Chemistry of Wheat Flour*. The Chemical Catalog Company, New York, 1925.

Ben-Gera, I., and Norris, K. H. Direct spectrophotometric determination of fat and moisture in meat products. J. Food Sci. 33:64, 1968.

Bolling, H. Milling of cereals for total utilization. In: *Cereals: A Renewable Resource*. Y. Pomeranz and L. Munck, eds. AACC International, St. Paul, MN, 1981.

Ferrel, R. 100 years of milling. AOM Tech. Bull. August:6773, 1996.

Geddes, W. F., Bergsteinnson, H. N., and Hadley, S. T. The influence of experimental milling in evaluating wheat strength. Cereal Chem. 10:555, 1933.

Gregory, D. Debranning: A miller's perspective. Int. Miller Quart. 1:37, 2010.

Hart, J. R., Norris, K. H., and Golumbic, C. Determination of the moisture content of seeds by near-infrared spectrophotometry of their methanol extracts. Cereal Chem. 39:94, 1962.

Hopf, L. *Muehlentechnisches Praktikum*. Hugo Matthaes Verlag, Stuttgart, Germany, 1950.

Lockwood, J. F. *Flour Milling*. The Northern Publishing Company Co. Ltd., London, 1945.

Marshall, F. L. A helpful hint in connection with Great Western sifter. AOM Tech. Bull. March:346, 1931.

Miag Co. *The Miller's Handbook*, 9th ed. The Company, Braunschweig, Germany, 1936.

Miller, J. C. *American Flour Millers Issues and Perspectives*. North American Millers' Association, Washington, DC, 2010.

Mohs, K. *Grundlagen und Ziele der Typisierung der Mehle nach Ashe*. Verlag Theodor Weicher, Inc. Inh. Karl Kaehler, Berlin, 1934.

Posner, E. S., and Wetzel, D. L. Control of flour mill by NIR on-line monitoring. Assoc. Operative Millers Tech. Bull. April:4711, 1986.

Posner, E. S. Wheat and flour ash as a measure of millability. Cereal Foods World 36:627, 1991.

Scott, J. H. *Flour Milling Processes*. Chapman & Hall Ltd., London, 1951.

Shellenberger, J. A. There is urgent need for standardized procedures for appraisal of wheat quality. In: *Internationaler Brotkongress*. Arbeitsgemeinschaft Getreideforschung, Detmold, Germany, 1955.

Sherwood, R. C., and Bailey, C. H. Correlation of ash content of wheat and flour. Cereal Chem. 5:437, 1928.

Smith, L. *Flour Milling Technology*. The Northern Publishing Co. Ltd., Liverpool, England, 1950.

Wetzel, D. L., Posner, E. S., and Dogan, H. InSb focal plane array chemical imaging enables assessment of unit process efficiency for milling operation. Appl. Spectrosc. 64:1320, 2010.

Willm, C. Die Entwicklung der Muellerei im 20. Jahrhundert in Frankreich. Muehle + Mischfutter 143:794, 2006.

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