CAKE FLOUR: FUNCTIONALITY AND QUALITY (*REVIEW*)

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Abstract

Many components are used in the production of cakes such as flour, water, sugar, milk, salt, leavening agent, flavors, additives and other food are allowed in the specifications. The quality and quantity of these components are important and influence on the properties of the final product as well as the stability of quality during shelf life. The most important factor in cakes making is the availability of soft wheat flour and the proportions of its components (8%) protein, gluten quality, strength and ash contents nearly (0.4 %). After mixing of cake flour and other ingredients form dough which accomplished to retain the leaved gas to reach the final soft structure of crumb and crust, volume, flavor and other quality parameters of cakes.

Keywords: Cake, flour, baking, quality, formula, ingredients

Introduction

Cake one of semi-dry foam foods that have air pockets enclosed in a protein and starch network. It is produced from fluid medium batters using rich characterized formulas that have been expanded by gas resulting from chemicals dissolved in the medium. Cake ingredients are soft wheat of cake flour and variable levels of fat, sugar, eggs, milk, baking powders, emulsifiers and other commonly used ingredients such as cocoa powder, nuts, fruits, icings, and certain flavorings are used for specialty cakes (Cauvain & Cyster, 1996; Cauvain &Young,2006).

In general, cake ingredients may be classified as tougheners, tenderizers, moisteners, or driers. In order to produce high quality cake, tougheners and tenderizers must be properly balanced. Flour works as a structure builder as it is involved in forming the crumb and crust structure of most types of cake and is considered a toughener. Changes in the cake ingredients have resulted in the development of many products having a wide range of characteristics. These can range from light to dense, rich, cakes. Cake quality is determined by three major factors: the appropriateness of ingredients for the specific type of cake being made, a properly balanced formula, and the optimum mixing and baking process (Cauvain & Cyster, 1996; Cauvain &Young,2006).

Sugar and fat tenderize the cake, softening, giving the soft structure, and enhancing the flavor·Eggs are drying, leavening agents and emulsifying agents of the batter ingredients .The role of baking powder is to enlarge the bubbles causing the cake to rise to its potential. A basic cake production process involves mixing, depositing, baking, cooling and packaging. The airy structure of cakes comes from emulsion and foam from egg proteins during mixing. Foam formation occurs during mixing where air cells are introduced into batter. The higher the number of air pockets the higher the volume. Starch gelatinization and protein denaturation together with carbon dioxide formation gives cake its porous and soft structure. A good quality cake should have high volume with a fine homogeneous moist crumb (Sahi *et al.,* 2003; Cauvain &Young2006).

To produce a cake with an open structure and high volume, a procedure and recipe is needed that creates a stable batter with many tiny air bubbles. These bubbles act as nuclei and grow in size when the carbon dioxide gas generated from baking powder leavens the product during baking. The aeration properties of batter cakes are based on the fat included in the formula. Integrating air into a cake batter can be practiced by three methods: creaming mixing, single step mixing, or continuous mixing. In the creaming mixing, fat and sugar are mixed strongly to integrate air into the fat; this is followed by the inclusion of the eggs, while the creaming action is continued. The last step is mixing the milk and flour into the batter. In the single-step method, all the ingredients are introduced into the mixing bowl at one time and mixed into a homogeneous mass. It requires an emulsifier to facilitate air assimilation. In continuous mixing, the batter is homogenized and emulsified by a high speed mixer and aerated by the integration of pressurized air (Sahi *et al.,* 2003; Sakiyan *et al.,* 2004).

Gas retention, crumb structure, and cake volume depend greatly on the quality and quantity of the gluten protein in the flour and how this gluten protein is developed during dough mixing. The amount of aeration is dependent on the viscosity of the batter. A low viscosity batter will fall short to hold the air cells in the structure resulting in a low volume cake. If the batter is thick, it would be difficult for the air bubbles to get away from cake, which would result in a high volume cake (Sahi *et al.,* 2003; Sakiyan *et al.,* 2004).

Baking of cake consist of three different steps. In the initial step, batter expansion and moisture loss occurs which is followed by further moisture loss and volume rise reaching to a maximum final step where air pockets are captured inside a cake The tiny air bubbles in the batter will only be released into the aqueous phase when fat melts during baking. These air bubbles will grow in size when the leavening gas is released during baking from the decomposing baking powder. This leavens the product until its structure is set when the starch in the batter gelatinizes and forms a starch gel (Sahi *et al.*, 2003; Sakiyan *et al.*, 2004). The aim of this review is to publish scientific information in cake flour to be an available for anyone in the world who is searching for cake flour which is too important for cake making.

Cake flour

The best cakes are obtained from a low-protein flour (7-9%) to give soft cakes. It is almost named as soft flour which is pure endosperm, small in particle size and a little of starch damage. Globally cake flour are producing by three ways; milling of soft wheat, milling of mixture of soft and hard wheats. In some countries that do not have the existence of soft wheat flour, cake flour produced from milling of hard wheat under various trade names (as in Jordan). Good milling skills can help to achieve cake standard characteristics, but obviously only if the wheat is already of the appropriate quality. The flour properties often depend on the experience of the millers, wheat varieties and composition that affected and determined the extraction rate, particle size, protein and ash (Cauvain & Cyster, 1996; Cauvain &Young, 2006; Edmund *et al.*, 2008; Al-Dmoor, 2012).

Cake flour is low ash and low protein content produced for best cake quality by milling technology of soft as well as hard wheat that is free of bran and wheat germ. Soft wheat flours are usually weak flour and low in water absorption. Also don't require strong mixing or long mixing time when working with a batter or a dough system for resulting products possesses qualities such as tenderness, softness, crispness, and good texture. The general composition for typical cake flour are water 14.5%, proteins 7 – 8%, starch 72 – 74%, sugars 1 – 2 % lipids 0.4 - 0.6 % cellulose 0.1 % and minerals 0.2 - 0.5%. Extraction rate for cake flour production is 50 % mostly are applied in flour milling (Edmund *et al.*, 2008; Al-Dmoor, 2012).

Al-Dmoor (2012) studied the properties of for 10 cake flour samples which often produced from one or mix of imported source of hard wheat in Jordan. The projects identify and advise about the averages requirements, specification of cake flour.The average results of include ; Extraction rate %, Protein%, Moisture %, Ash %, Wet gluten%, Dry gluten %, Gluten Index, α amylase, Acidity %, Damaged starch, Particles size are ; 51.66, 8.82, 14, 0.5, 24.1, 8.44, 98.35, 310.3, 0.15, 7.71, 10.07 respectively. While the rheological properties of cake flour of hard wheat Development Time, Stability, Elasticity, Softening, Water absorption, resistance, extensibility and R:F for dough are;1.35, 3.1, 102, 89.4, 57.73, 98.6, 357, 155, 2.31 respectively. The study concluded the miller can produce flour with nearly percentage of soft wheat flour compositions but the rheological properties aren't suitable for cake making with a high quality cakes. The study also advice to apply a special treatment or using additives by the flour miller or producers of cake to improve the rheological properties cake flour which is produced from hard wheats.

Role of protein

Milling of hard wheat yields strong flour with higher protein content. On the other hand, soft wheat on milling yields weaker flour with slighter protein content. The strong flour is generally used in the production of yeast leavened bakery products such as bread and buns, whereas the weak flour is found appropriate for the production of cakes. Weak flour proteins do not form a continuous gluten matrix when flour is mixed with water due to smaller quantity and basic quality characteristics of gluten proteins in weak flour. The conditions of dough preparation for soft wheat products such as low quantity of water addition and higher amounts of sugar and in the formulation with low energy inputs favor dough preparation that is crumbly and extensible but lacks strength and elasticity. Dough with such characteristics extends more when subjected to higher temperature in the baking and more numbers of biscuits are obtained from a given mass of dough (Kim &Walker, 1992; Cauvain &Young, 2006; Edmund *et al.,* 2008).

Gluten provides the structure in baked goods which affects by the quality and quantity of gluten. Higher amounts of gluten proteins are not desirable for cake production because large amounts of gluten proteins prevent spread of dough and hampers molding of dough to specific dimension and shape. The larger amounts of gluten proteins make the dough stronger and elastic that contracts/recoils after sheet formation. The glutenin proteins are held responsible for the strength and elastic nature of dough or gluten. These proteins favor gas retention and hence volume of bakery products. Gliadin are globular proteins in nature, less surface areas which is good for the interaction with other flour constituents to enhance the extensibility of dough. Soft wheat with lower protein content produces flour with low water absorption, low starch damage content, fine flour granulation and low to medium mixing requirements, are considered suitable for the production of good quality cakes (Kim &Walker, 1992; Cauvain &Young, 2006; Edmund *et al.*, 2008).

Role of starch

The starch has also been shown to affect the cakes quality. Gelatinization of starch during baking plays important role in producing internal texture of cakes. Starch also contributes to the crust color formation of biscuits and cookies. At temperature above 180°C, the starch begins to get converted into dextrin that undergo caramelization and thus, contributes to the crust color of bakery products with sugar rich formulation. Increasing starch content in wheat flour increases the diameter and spread factor of cakes. This may be due to the dilution of gluten by increase in level of starch in the dough. Lesser amount or dilution of gluten improves the extensibility and spread of dough during baking (Kim &Walker, 1992; Cauvain &Young, 2006). .

Damaged starch is one that has been physically damaged during the wheat milling process which differs between flours milled from different wheat varieties. For example milling of a hard variety requires more energy and thus severity of grinding results in higher percentage of damaged starch in hard wheat flours. By contrast, lesser energy is needed to grind soft wheat grains to desired particle size flour and hence the soft wheat flour generally has lesser percentage of damaged starch. Therefore, the proportion of damaged starch in flour is of great importance to the rheological and baking quality of the flour (Kim &Walker, 1992; Cauvain &Young,2006; Edmund *et al.,* 2008).

Role of lipids

Wheat flour lipids constitute about 1% of flour but make important contribution to dough properties, baking behavior and staling. Like bread, the quality of cakes is assessed by their volume, internal texture, softness and freshness. However, cakes differ from bread and cookies in the sense that they are baked as batters (loose dough). Cake flour is generally treated with chlorine to bleach the flour and to enhance its baking potential. It is also agreed that chlorinating flour modifies functionality of lipids. The lipids play a role in foam production and stability of cake batter (Kim &Walker, 1992; Edmund *et al.,* 2008).

Flour treatments

Special treatments and additives are applied or used by the miller or producers of cake to improve the rheological properties cake flour produced from hard wheats that include.

Chlorine

The treatment of flour with chlorine gas was first identified in the 1920s and was used for the modification of the cake making properties of flours for many years in the UK, the USA, Australia, New Zealand, South Africa and many other countries. The use of chlorination for cake flour treatment was withdrawn in some countries but remains permitted in many other of contrary world. The flour should be well bleached with chlorine bleach, to a pH level of 4.4 - 4.8 (Finnie *et al.*, 2006).

Chlorination of flour offers two enormous benefits. First is bleaching, which gives a better crumb color but second and more significantly it lowers the gelatinization temperature of the starch within the flour. This makes it possible for the cake to set faster and therefore decreases the loss of leavening during baking. Bleaching also gives the flour the ability to carry more sugar and fat as well as water. Bleached flour must be used in high ratio cakes where the sugar is higher than the flour level (Finnie *et al.,* 2006). According to the food additives, codex standard (192) which has been evaluated by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) that found the acceptable level of chlorine is 2.5 mg/kg flour and 30 mg/kg flour for chlorine dioxide (Codex 2011).

Ozone

Ozone can be used as an alternative to chlorine with some benefits. The oxidizing power of ozone is greater than chlorine, and by-products of ozone treatment are less harmful compared to chlorine since halogen-substituted DBPs are not formed in the absence of bromide. Ozonation of cake flour decreased pH and increased the lightness (L value) of flour. Baking studies using a high-ratio white layer cake formulation showed that the volume of cakes significantly increased as ozonation time increased and cakes were softer than those made with chlorinated were or control flours (Dubois *et al.,* 2006).

Xanthan gum

Treat of unchlorinated soft wheat flour at 7% flour moisture for 30 min at 125 C, and supplementing that flour with 0.12% xanthan gum, produced cakes with volumes that were slightly greater than those of cakes made with the chlorinated control flour. The crumb grains were essentially equivalent (Donelson *et al.,* 2000; Thomasson *et al.*, 1995)

L-cysteine

The addition of 200 or 300 ppm L-cysteine to cake batter made with unchlorinated, heat-treated flour also produced cakes with volumes and crumb grain scores equal to those of cakes made with the chlorinated control flour (Thomasson *et al.*, 1995).

Hydrogen peroxide

Addition of hydrogen peroxide plus peroxidase to the cake formula containing heat-treated flour also improved the cake volume, grain, and color. However, the volume was less than that of the cakes made with the chlorine-treated control flour. Heat treatment also reduced the degree of shrink of the cake during baking to a value equal to that of the cakes made with the chlorinated control flour. (Thomasson *et al.*, 1995)

Heat treatments

Heat treatment at 120 °C of cake flour improved its cake-baking properties. Flour baking performance was improved when the moisture level of the flour was reduced to less than 7% during treatment. Although the flour's cake baking quality improved compared to that of the untreated control, the quality of the cakes was not equal to the quality of cakes made with the chlorinated control. Many studies carried on the effect of heating and storage on the functional qualities of flour. Flour stored at room temperature for two months resulted in cakes with improved volume and grain. These age-related changes were accelerated by heat. Heat treatment of unaged flours improved the crumb grain and eliminated collapse during baking. (Thomasson *et al.,* 1995)

Microwave heating treatment

Newly microwave heating treatment of unchlorinated cake flour restores the ability of starch to gelatinize and swell the swollen. Gelatinized starch granules provide the honeycomb open-celled structure of the finished cake, which stabilizes it against collapse upon cooling. Starch gelatinization also contributes to crumb tenderness, slightly dry texture and development of fine-grained cells.

Cake flour quality

Moisture

The level of moisture in flour is important mainly for the issue of storage. When the moisture level exceeds 16 % the shelf life of the flour is greatly reduced. Generally, the moisture will be 14-15%, which when stored in appropriate conditions (relatively cool, dry and aerated) allows for plenty of shelf life. There is a correlation between moisture content and water absorption but can be counteracted by starch damage (Edmund *et al.,* 2008).

Ash

The ash content tells us something about the extraction of the flour. In the endosperm of the wheat kernel, the mineral content increases from the centre outwards. The area of the endosperm nearest the aleurone and bran layers has the highest mineral content. Higher ash contents indicate higher extraction. Most flours will have ash content below 0.8%, cake flours can go as low as 0.5% (Edmund *et al.,* 2008).

Color

After milling of cake flour, a whiter color powdered, is intended for white cake production. The bleaching agent can also be added to the flour for carotene color removal or creamy color removal, which is important if the flour.

Color grade measurement is conducted on a flour and water paste using the Kent-Jones and Martin Flour Color Grader. Color grade varies with the level of bran powder in the flour and therefore provides a measure of flour 'grade' (or quality), rather than actual flour color. A low-color grade result indicates clean, bright, high-grade flour, while a high result indicates dull flour of low grade. Color grade and flour ash are generally well correlated since both are closely related to the milling extraction (Edmund *et al.,* 2008).

A very simple way to determine color differences in different batches of flour is to look at the color of different types of flour under a sheet of glass. Minolta color values are measured using a Minolta CR300 series Chroma Meter. The Minolta (L) value indicates whiteness and brightness on a scale of 0–100; the whitest flours having the highest (L) values. Minolta (b) values indicate yellow hue on a scale of 0–60 with yellower flour having higher (b) values. Yellow pigment is extracted in water-saturated N-butanol and allowed to stand for 16–18 hours. The resultant solution is filtered and the extract is analyzed on a UV-visible spectrophotometer at 440 nm against a calibration curve of tertiary standards to give a result in micrograms per gram. This test is conducted according to AACC Method(AACC, 2000).

Texture & particle size

The milling process determines the degree of separation of the bran and endosperm, as well as the particle size of the flour, an important factor in cake flour. The delicate, fine texture of cake flour is accomplished by heavy milling. The fine grain absorbs readily, ensuring that butter and other s in cakes are well distributed throughout the batter. Cake flour can also carry a high volume of sugar when compared to higher protein flours. Since cake flour is high-starch flour, it is extremely well suited for certain baking tasks. When baking a cake, most cooks aim to create a light, feathery cake with a tender crumb. This requires flour with low protein content, as protein promotes the production of gluten, which can make baked goods tougher. It also means that the flour must be very finely milled, to keep baked goods from getting heavy. All of these needs are addressed with cakeflour, which is made from the endosperm of soft wheat. The endosperm is the softest part of the wheat kernel, making cakeflour the finest flour available. As cakeflour is milled, it is seriously bleached, not only to make it white but to break down the protein in the flour. Normally, cakeflour is around 7-8 % protein, much lower than other flours; bread flour, for example, has twice that amount of protein. The recommended particle size for typical cake flour is 10 ± 0.5 microns (Edmund *et al.,* 2008).

Water absorption

Absorption measures the amount of water that can be absorbed by a given quantity of flour. In bread making, it is usually preferable to have flour that can absorb a large amount of water. Measurements of absorption are done to determine the amount of water the dough can absorb, which in turn indicates dough yield and shelf life. Optimum absorption represents the maximum amount of water, as a percent of the flour weight that will produce a high yield of bread during the baking process. Typically, cakeflour is around 56-58% water absorption (Edmund *et al.*, 2008).

Expansion and Extensibility

Several factors determine the rising ability and elasticity of particular flour. Alveograph or / and Extensograph is used to determine the relationship between the elasticity of the dough and rising power (Edmund *et al.*, 2008; Sahin, 2008).

Alveograph

The alveograph test provides results that are universal specifications used by flour millers and processors to ensure a more consistent process and product. The alveograph decides the gluten strength of dough by measuring the force required to blow and break a bubble of dough. The results comprise (P), (L) and (W) Values. (P) Expresses the resistance of the dough to deformation, and is related to the dough's tensile strength and stability. It is measured in millimeters (mm) and then multiplied by the factor 1.1. Flours with a high (P) value tend to have high gluten content and absorb a relatively large quantity of water. (L) Measures the distance, in millimeters, from the start of the curve to the point where the dough bubble ruptures under the conditions of this test. (L) represents the extensibility of the dough or its ability to rise. Measuring the area under the curve and then multiplying it by another factor (6.54) affords the value of (W). (W) Is proportional to the baking strength of the dough.

Dough of hard wheat flour requires more energy to break the bubble (higher (P) value). A bigger bubble means the dough can stretch to a very thin membrane before breaking. A larger bubble indicates the dough has higher extensibility. A larger bubble requires more energy and will have a greater area under the curve (W). Values of (W) range from 45 for very soft flours to 400 for very strong, hard red wheat flours. The relationship between (P) and (L) expressed as a ratio serves as an index of gluten behavior. High values of (P) and (W) indicate strong flour. The ranges of values for (W) 120 – 160 indicate for weak flours which appropriate for the production of cake. The (P/L) serves as an index to the performance of the gluten and expresses the relationship between the tenacity and extensibility of the dough, connoting a value of equilibrium or unbalance between these two factors. The alveograph is well suited for measuring the dough characteristics of weak gluten wheats. Weak gluten flour with low (P) value (strength of gluten) and long (L) value (extensibility) is preferred for cakes, other fine bakery, and sweet products. Strong gluten flour will have high (P) values and is preferred for breads (AACC, 2000).

Extensopraph

Dough is proved for 45, 90 and 135 minutes then at each step the dough is installed into a cradle in which the dough is stretched to breaking point. The graph generated from this process conveys information about the properties of the flour from which the dough was made. The extensogram is a load-extension curve, recorded by an extensograph, for a dough test piece that has been subjected to control stretching to breaking point. Measurements taken from the extensogram curve are the extensibility (cm), the maximum height or resistance to extension (BU) and the area under the curve or energy value (cm^2). Extensograph results are particularly useful for evaluating dough strength and observing changes in dough properties over an extended period, and for characterizing different flour and wheat types.

The area within the curve is measured is reported in cm^2. This indicates the total energy required to stretch the dough. This indicates the efficiency of the dough during fermentation for examples, the higher of the area under the curve, the greater the tolerance and vice versa. The resistance (R) is measured in BU (the peak force during the curve creation) .The extensibility (E) is measured in mm along the base of the curve and indicates the stretchability of the dough. The ratio (R/E) is calculated as the resistance quotient of resistance to extensibility. When combined with the energy reading indicates the dough behavior, stability and potential baking volume. Compared with bread flour extensogram measurements are 400, 190 and 2.11 for (R),(E) and (R/E) respectively, the typical cake and biscuit flour measurements are 130, 160 and 0.81 for (R),(E) and (R/E) respectively (AACC, 2000).

Farinograph

Farinograph determines the degree of softening of the dough when mixed for too long. This provides information about the dough stability. Particularly, Farinograph tests determine water absorption that is required to give a sample of dough a fixed consistency, the peak time which shows the relative strength of the flour, the arrival time, the departure time, the mixing tolerance index (MTI) is represented by the difference between the peak time and the departure time, and is a measurement used to indicate the mixing requirements of the flour and stability time. All dough eventually breaks down on sustained mixing. Excellent quality flour breaks down at between 0 and 30 Brabender Units and has a stability time, expressed as (S) of greater than 10 minutes. Week quality flours breakdown between 70 and 130 BU's and have stability time of not less than three minutes (AACC, 2000).

Mixograph

The mixograph test quickly analyzes small quantities of flour for dough gluten strength. Flour water absorption measured by the mixograph often serves as bake absorption in bread baking tests. The mixograph test measures and records the resistance of dough to mixing with pins. Peak Time (the dough development time) indicates optimum mixing time and is expressed in minutes. Mixing tolerance is the resistance of the dough to breakdown during continued mixing. This indicates tolerance to over-mixing and is expressed as a numerical score based on comparison to a control. Weak gluten flour has a shorter peak time and less mixing tolerance than strong gluten flour (AACC, 2000).

Sedimentation test

The Zeleny sedimentation test is used as a fast means of estimating the baking quality of wheat flour. The test depends on the relationship between flour baking strength and gluten hydration capacity, which indicate to gluten quantity and quality. The Zeleny test involves measurement of the rate of sedimentation of the solid phase following suspension of the flour in an aqueous lactic acid solution. The presence of lactic acid in solution causes the hydrated flour particles to fall in the form of sediment, the level of which indicates the strength of the gluten. Sedimentation values can be in the range of 20 or less for low-protein wheat with sweak gluten to as high as 70 or more for high-protein wheat with strong gluten (AACC, 2000).

Solvent retention capacity

Solvent retention capacity (SRC) is the weight of solvent held by flour after centrifugation. It is expressed as percent of flour weight, on a 14% moisture basis. Four solvents are independently used to produce four SRC values: water SRC, 50% sucrose SRC, 5% sodium carbonate SRC, and 5% lactic acid SRC. The combined pattern of the four SRC values establishes a practical flour functionality profile useful for predicting baking performance and specification conformance. Generally, lactic acid SRC is correlated with glutenin characteristics, sodium carbonate SRC with levels of damaged starch, and sucrose SRC with pentosan characteristics. All of flour constituents influence water SRC .(AACC, 2000)

Flour quality for baking performance in different end-use applications is related to a behavior pattern of SRC values, with different patterns being optimally suited for different products. For example, cookie flour may perform well with water SRC 51%, sucrose SRC 89%, lactic acid SRC 87%, and sodium carbonate SRC 64%. A sponge and dough system may achieve well with water SRC 57%, sucrose SRC 96%, lactic acid SRC 100%, and sodium carbonate SRC 72%. However, conformance of bakery production will be improved if SRC values change little between different lots of flour (AACC, 2000).

Rapid visco analyzer

The rapid visco analyzer test evaluates flour starch properties. Flour of medium to high peak viscosity is preferred because it gives some of starch flour properties and alpha amylase enzyme activity. The rapid visco analyzer can also be used to determine the sprout damage. It a test is performed to measure enzyme activity that result from sprout damage. Sprouting in wheat results in flour and produces sticky dough that can cause problems during processing. Sprout-damaged flour also produces products with poor color and weak texture. The rapid visco analyzer values can be as; peak height 3700 cp, break down 1200 cp, final viscosity 3000 cp, peak time 6 min and the pasting temperature is 80 °C for low-protein wheat with weak gluten. For cake flour no recommended values was found (AACC, 2000).

Amylograph

The amylograph test measures flour starch properties and enzyme activity, which results from alpha amylase enzyme activity when sprout damage are taken place. Peak of viscosity is the maximum resistance of a heated flour and water slurry to mixing with pins. It is expressed in Brabender units (BU) Sprouted wheat flour has a lower peak viscosity than sound flour. For cake flour no recommended values was found (AACC, 2000).

Falling Number

The quantity of amylases contained in flour determines the rate at which starch is converted to sugar. The falling number (or Hagberg Index) is indicative of the amylase (specifically alpha-amylase) activity and the fermentation process taking place in wheat flour dough. It is based on the rapid gelatinization of flour suspended in water and determines the degradation of starch made available from alpha-amylase activity in rising temperature conditions during baking. The falling number values for the cake flour around 250 second minimum (AACC, 2000).

Damaged starch

Some starch granules of flour are damaged during milling of wheat, and the degree of damage affects water absorption and dough mixing characteristics of the resulting flour. The starch damage is held mostly responsible for differences in water absorption, dough handling properties, and sugar and gas production. The water holding capacity of damaged starch enlarges four times of the normal starch. The water holding capacity of normal starch is reported to be 0.44 g water/g of dry starch, while damaged starch can hold as much as 2.0 g water/g of dry starch. Damaged starches determine of by using Spectrophotometric method AACC method. In this method, damaged starch granules are hydrated; this is followed by hydrolysisto maltosaccharides and limit dextrins by fungal alpha-amylase. Amyloglucosidase is then used to convert dextrins to glucose, which is specifically determined spectrophotometrically after glucose oxidase/peroxidase treatment. Damaged starch is calculated as a percentage of flour weight on "as is" basis. This method is applicable to wheat flour and starch. Desired level of damaged starch for cake making, damaged starch should be < 7%, as higher per cent of starch damage makes the starch more susceptible to enzyme attack that results in smaller cookies.

Textural properties

A texture analyzer is mostly used to measure hardness, springiness and cohesiveness of cakes. For crumb, cellular structure differential scanning calorimeter measurements, X-Raydiffraction analysis and non destructive X-ray microtomography technique (XMT) are used to analyze cellular structure of the samples (AACC, 2000).

Color of cakes

The color of the cake crumb was measured with a Minolta colorimeter (CR-300) (AACC, 2000).

Gas cell structure

Gas cell structure of cakes was performed via an image analysis instrument. Cakes were sliced with an electric knife and central slices of 15 mm thickness were used. Image analysis parameters including slice brightness, number of cells, and cell diameter were used to compare different treatments (AACC, 2000).

Specific gravity

Specific gravity is determined by dividing the weight of a material by the weight of an equal volume of water. To determine the specific gravity of cake batter, a graduated cylinder with a 50 ml capacity was taken and the weight of both water and cake batter were measured. The large air pockets that could occur while pouring the batter into the cylinder were removed by lightly tapping the beaker (AACC, 2000).

Moisture content

Cake samples were crumbled from the interior crumb of the cake and dried to constant weight at 135 ^{o}C on pre-dried al dishes. After drying to a constant weight they were transferred into desiccators to cool down to room temperature (AACC, 2000).

Water activity

Water activity determined using any water activity meter. Water activity was measured on both fresh cakes and cakes stored for shelf life analysis. Prior to each test, the meter was turned on and allowed to warm up for 30 minutes. The water activity meter was calibrated by filling a plastic disposable cup half full with a saturated potassium chloride solution, which had a water activity similar to that of a cake. Each sample was measured by covering the bottom of a plastic disposable cup with a small portion from the interior crumb of the cake, placing the cup into the sample holder, and taking the reading (AACC, 2000).

Volume and symmetry

The volume and symmetry indices calculated by using a layer cake-measuring template as described in AACC Method (AACC, 2000).

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