

CHAPTER II

LITERATURE REVIEW

2.1 Background

Bread is an important product of wheat as its consumption is virtually everywhere around the globe (Poutanen et al, 2014; Whitehurst & Oort, 2010). It is a staple food of most developed countries (Fitzgerald et al, 2014) and second to rice in Malaysia. "bread has been labelled as the most popular substitute of rice, the staple diet of Malaysians" (Ling, 2011).

A global increase in sedentary lifestyles and the alarming epidemics of metabolic disorders, such as obesity, cardiovascular diseases, diabetes is pushing developed countries including USA to focus their research in bread on healthily (Jimenez-Maroto et al, 2013; Lynch et al, 2009) and nutritional issues (Dewettinck et al, 2008), from wheat breeding (A-Saleh and Brennan, 2012), milling researches (Campbell et al, 2012; Tilley et al, 2012) down to dough fortification (Blandino et al, 2013; Fitzgerald et al, 2014). Africa and other developing countries that depend on wheat importation are now embarking on composite bread, a strategy to reduce cost of production with higher degree of success (Dooshima et al, 2014; Jensen et al, 2015; Malomo et al, 2011; Shittu et al, 2007).

Bread is a product obtained from fermentation and subsequent baking of dough from flour, sugar, yeast and water. There are different types of bread that can be made and some include fruit bread, wheat bread, high fiber bread, coconut bread, and banana bread etc. (Das et al, 2012; Kittisuban et al, 2014). Though the most consumed food products globally, bread require more investigation because of its complex and delicate production process. It does not allow process modification and product cannot be salvaged once outside the desired parameters of the processing line. In order to save time and reduce production cost brings about the usage of bread improver in commercial and domestic bread baking.

2.2 Bread Improver

Bread improvers are blends of functional ingredients, which enhance the development of dough structure, facilitate trouble-free production and provide the desired result of consistent products of optimal quality at the lowest possible cost. It is intended to facilitate or simplify the production of bread, to compensate for changes in processing properties due to fluctuations in raw materials and to influence the quality of baked bread (Wassermann and Neu-Ulm, 2009).

The science of improvers has enabled the baking industry, despite all these modern day challenges, to produce a quality product consistently and economically. The ingredients of improvers interact with each other and interact with the different components of the flour, mainly the starch and gluten. Therefore, a biochemical reaction that benefits both processes and products occurred (Della Valle et al, 2014). This aids gas production during the fermentation process and help in retaining the gas by strengthening the gluten that forms

the cell structure of the bread. Major components of improver are enzymes, oxidizing agent and reducing agents.

2.2.1 Enzymes

Enzymes are biology catalysts, proteinous in nature; they are substrate specific and accelerate chemical reactions. Amylases, proteases and lipoxygenases are the major enzymes in baking products. Amylases convert starch into sugar and can be present as α -amylase or as β -amylase. Flour usually requires additional α -amylase. Proteases are associated with proteins. They weaken proteins thereby speed mixing process, enhanced dough machinability, improve handling and rheological properties. Lipoxygenase is a bleaching enzyme especially of soy flour.

Enzymes make critical flour more suitable for baking; add consistency to the process of baking, allowing bake characteristics of the flour to be more controllable and predictable. This helps in dealing with fluctuating quality of raw grain, which could result in problems such as excessive mix times, crumb colour and dough strength.

Enzymes are useful in relaxing strong wheat flour, to prevent shrinkage and breakage. Gluten-strengthening enzymes help unlock the strength potential of natural gluten in the flour. The result is greater dough stability with better volumes and improved appearance. Ali and Halim (2013) was able to use natural improvers containing emulsifier and enzymes as cover up of sesame flour in composite bread to produce quality and competing product.

2.2.2 Oxidizing and Reducing Agents

Oxidizing agents are used to improve the dough handling characteristics, specific volume and finished product texture. The safest and commonly used oxidizing agent is ascorbic acids (AA). Oxidants are used to improve the structure, volume of bread and to increase the dough strength.

Ascorbic acid has been widely used as an oxidant in the baking industry. It is an oxidizing agent that strengthens the gluten network by creating disulphide bonds (S-S) through oxidation of SH groups and prevent short chain proteins (glutathione) from reacting with gluten molecules (Umelo et al, 2014). Reducing agents reduces kneading force, lowers fermentation time by prevents gluten rupture and increases SH-groups. Reducing agents are used to weaken short chain proteins and the commonest is L- cysteine (Horvat et al, 2009).

Improvers' usage in bread has many variations, and basic functions are-

- Improves bread volume.
- Improves crumb structure and texture of the loaf.
- Help in dough development.
- Reduces the rate of crumb firming and bread staling.
- Improve gas retention of the dough and dough machinability.
- Improve dough tolerance to mechanical shock during mixing and mold figuring.
- Faster dough development.

2.3 Bread Making Quality

The formation of dough begins with mixing flour and water to homogeneously hydrate flour particles (Ross and Bettge, 2009; Wassermann and Neu-Ulm, 2009). There are commonly two techniques of mixing, the Straight dough method and the sponge method (Dennis, 2012; Ishida and Steel, 2014).

The original process accepted by bakery industry is the Straight dough method, the needs for alternative methods aroused and new methods developed (Ross and Bettge 2009). In the Straight dough method, all ingredients are combined once and then left for fermentation to occur.

In the sponge and dough method, half of the formulated flour and water are fermented. The resulting sponge later mixed with the remaining ingredients for the final developed dough. The sponge and dough process is claimed to offer greater flexibility in processing, more product uniformity, higher loaf volume, better crumb grain, and softer texture (Dennis, 2012; Ishida and Steel, 2014; Kulp and Ponte 2000, Pyler 2008) due to a more extensible dough after remixing (Cauvain and Young 2007).

The aim of dough processing methods is to improve gluten elasticity and gas retention capabilities (Kihlberg, 2004). During the mixing process, glutenin and gliadin in wheat flour combined to form gluten (Delcour and Hoseney, 2010; Kihlberg, 2004).

Bulk fermentation helps the protein structure through a prolonged resting period while the energy intense approach accelerates the process. Folding or punching the dough during bulk fermentation subdivides CO₂ inflated cells into smaller cells preventing their reunion thus resulting in a finer and more uniform cell structure (Stauffer 1999).

The level of energy applied during mixing has been associated to loaf volume and crumb texture. Requirements specific to dough for bread include consistent formation of cohesive, elastic, and relatively soft dough, which can be molded into a desired shape that resists deformation without excessive stickiness (Cauvain and Young 2007). The degree of elastic and viscous dough attributes must be balanced for dough strength to endure stress during processing (mixing, fermentation, dividing, molding) and retain fermentation gases in order to form the desired aerated breadcrumb and soft texture (Della Valle et al, 2014; Stauffer 1999).

2.4 Basic Ingredients and Their Function

2.4.1 Wheat Flour

Flour, the most significant ingredient in bread production can be defined as the powder or particles that result from the crushing or milling of starchy seeds, grains, tubers, or legumes. It can come from grinding unconventional foods like potatoes or beans. Wheat flour is the preferred grain for bread making because of its ability to capture the gases from fermentation and thereby leaven bread. Wheat flour is the most accepted flour in baking generally, the unique viscoelastic capability of dough (Scanlon and Zghal, 2001) made from wheat flour allow it to be used for a wide range of products including bread, cakes, cookies, doughnuts, bagels, pizza, flat bread, pasta, noodles, and chapatti (Ndife et al, 2013; Wrigley 2009). Usage of other flour has not been possible without wheat flour, and it takes larger percentage when composite flour is to be adopted (Jensen et al, 2015; Shittu et al. 2007; Villarino et al, 2015).

The characteristics of a flour depend on the variety of wheat from which it is milled, the location where it is grown, and its growing conditions (Svec and Hruskova, 2010). Some wheat are hard and some are soft. Hard wheat contains greater quantities of the proteins called glutenin and gliadin, which together form gluten when the flour is moistened and mixed. Kernel hardness effects milling capacity, flour yield and application (Tilley et al, 2012), starch damage, and determine particle size (Campbell et al, 2012; Kihlberg, 2004; Tilley et al, 2012).

The primary goal of milling is to produce the highest yield of flour possible from the endosperm without excessive contamination by bran or germ. As the extraction rate increases baking performance deteriorates (Dewettinck et al, 2008; Tilley et al, 2012) because more lipids, ash, and fiber originating in the germ and bran are lost (Campbell et al, 2012; Tilley et al, 2012).

Strong flour is flour from hard wheat with high protein content and is used primarily to make bread and other yeast products. Weak flour is flour from soft wheat with low protein content and is useful in the production of cakes, cookies, and pastries.

Table 2.1: Wheat Classification

Variety	Protein content	Kernel colour	Planting season	Harvesting season	Usage
Soft red winter	8-11%	Red	Fall	Early summer	Cake, pastry flour
Soft white winter	8-11%	white	Fall	Early summer	Cake, pastry
Hard red winter	10-15%	Red	Fall	Early summer	Bread flour
Hard white winter	10-15%	White	Fall	Early summer	Bread flour
Hard red spring	12-18%	Red	Spring	Fall	High gluten flour
Durum	14-16%		Spring	Fall	Semolina, durum flour

Source: DiMuzio, (2010)

2.4.1.1 Flour Composition

Flour consists of protein, starch and other carbohydrates, ash, fibers, lipids, water and small amount of vitamins, minerals and enzymes. Starch is the main constituent of flour (68–76%) consisting of amylose and amylopectin (Seamless and Zghal, 2001). The starches in flour are contained in tiny granules. Most of these remain intact until they are exposed to water during the mixing process, at which time they absorb water and swell in size. Starch can absorb from one-quarter to one-half its weight in water. Amylose is less stable (74-90%, dry basis) and has many roles in dough development and baking.

Starch provides fermentable carbohydrate for yeast fermentation and fills interstitial space between the gluten gel and gaseous cells in dough. During gelatinization in baking, the starch structure swells with water absorption and leaches amylose (Adebawale et al,

2008) to form an amorphous gel. During retrogradation, starch recrystallizes and the gel network rigidifies with time leading to bread staling (Fennema, 1996; Oliveira et al., 2014).

Starch damage occurs during milling and is an important factor to regulate (Campbell et al, 2012). Excessive starch damage levels increase water absorption four fold higher than the normal level (Stauffer 2009), which results in sticky dough and causes a poor bread loaf volume (Tilley et al, 2012). Damaged starch is susceptible to breakage by alpha amylase during proofing and fermentation, resulting to significant rheological changes (Stauffer, 2009).

Protein content of white flour is around 6 to 18 % (Scanton and Zghal, 2001), depending on the variety of wheat. Proteins act as binding agents that hold the starch granules together in the endosperm. About 80% of the proteins in flour are called glutenin and gliadin. When these two proteins combined with water and mixed in a dough form an elastic substance called gluten (Delcour and Hoseney, 2010). Without gluten, it is impossible to make familiar yeast-raised bread, because gluten provides their structure. Gluten proteins can absorb about two times their weight in water.

Other proteins present in white flour are enzymes such as protease, amylase, also called diastase are present. This enzyme breaks down starch into simple sugars, which is important for yeast fermentation. Lipids constitute approximately 2.5% (w/w) of flour with 1% being non-polar lipids (monoglycerides, diglycerides, free fatty acids and sterol esters) and 1.5% polar lipids (galactosyl glycerides 0.6% and phospholipids 0.9%) constituting the remaining portion (Stauffer, 2009). Pareyt et al (2011) theorized the polar lipids bound with gluten serve as a stabilizer at the gas cell interface to aid gas retention throughout dough

processing thus, are important for gluten development. Lipids spoil easily, giving flour an off flavour and therefore responsible for the limited shelf life of flour.

Non-starch polysaccharides (cellulose, glucans, and pentosans) make up about 2-2.5% of flour. Pentosans are water-soluble (65%) or water-insoluble (35%). Pentosans increase viscosity by absorbing several times their weight in water and forming bonds with gluten proteins (Stauffer 2009). The mineral content left behind after flour incineration is ash (AACC, 2010) and can be used as a measurement of flour refinement (Dennis, 2012).

2.4.1.2 High and All-Purpose Flour

High gluten flour contains 12 to 15 percent gluten and is the predominant flour of choice for bread production (Dennis, 2012); however, not all varieties create dough with optimum handling properties (Ross and Bettge 2009). All-purpose flour is generally referred to as all-purpose flour. It is relatively available and cheaper and as such gain familiarity among consumers.

All-purpose flour, as the name suggests, is a type of wheat flour that is suitable for most purposes. It is generally produced from a combination of high and low protein flour with gluten level between 10 to 12 percent. The bread flour is a variety of hard wheat that contains between 12 and 14 percent gluten that is necessary for baked items to rise properly (Dennis, 2012; Gisslen, 2013).

2.4.1.3 Gluten as a Standard of Wheat Flour Quality

Bread making quality of wheat flour is predominately determined by its proteins (Campbell et al, 2012; Horvat et al, 2006, 2009), quality bread is an outcome of superior flour in terms of quantity and quality of its protein. Gluten plays a major role for the rheological properties of the dough, forming a strong, elastic and cohesive network that retains gas during fermentation and eventually produces a light and leavened bread. Within a wheat cultivar, the protein content of hard wheat flour (9-18%) was reported to be associated to loaf volume (Shittu et al, 2007).

Protein quality, a trait much more difficult to quantify, must be considered because the correlation is not seen in all wheat varieties. Causal links between protein class and baking quality have been observed through fractionation and reconstitution experiments in which all flour components are separated and reincorporated with either varying levels of protein, protein fractions, or exchanging protein fractions of flours differing in baking quality if the flour blends are reconstituted in the correct proportions, the resulting change in dough characteristics and bread quality are a result of the alteration (Dimuzio, 2010).

In a study using poor and good baking quality flour, the interchange of gliadin exhibited a minor influence as compared to interchange of the glutenin fraction (Campbell et al, 2012). Altering gliadin and glutenin ratio while maintaining total protein content revealed relative glutenin quantity to be directly related to dough or gluten strength.

Some other studies revealed that fractionated gluten proteins by successive extraction with increasing HCl molarity has gliadin fraction as a whole weakened dough and slightly decreased loaf volume in some cases, while the glutenin fraction increased

dough strength and loaf volume (Campbell et al, 2012; Gisslen, 2013), and the remaining residue proteins depressed loaf strength and volume. Hydrophobic gliadins are linked with an increase in bread loaf volume while hydrophilic gliadins are associated with a loaf volume reduction.

2.4.2 Yeast

Yeast (*Saccharomyces cerevisiae*) known as baker's yeast is a single-celled eukaryotic organism in the fungal kingdom used as essential ingredients in bread production. It prefers to feed on sugars such as glucose, fructose, sucrose, and maltose, it can feed directly on foods that are high in sugar, such as ripe fruits and vegetables, honey, beets, and cane sugar, and likewise sugars converted from plant starch by the enzyme amylase. Under the right conditions of water, sugars, warmth and dissolved minerals, yeast causes fermentation (Villarino et al, 2015). Aroma produced by bread during baking has a link with yeast (Birch et al, 2013). Yeast cells can produce their own enzyme, zymase, to help them obtain energy from sugars, leaving behind the by-products carbon dioxide and alcohol.



They are available in compressed form or as active dry yeast to suit storage and usage needs. Yeasts are useful in baking and brewing industry, and in distilling industries (Joseph and Bachhawat, 2014; Villarino et al, 2015). In bread making, as reported by Therdtai et al. (2002) yeast fermentation proceeds at an accelerated rate in the oven until it is killed at about 60 °C to allow dough to crumb transition and crust formation.

2.4.3 Water

Water is a basic ingredient in bread baking and constitutes between 50 and 60% of the flour amount. Yeast requires water to get activated, gluten formation demands for water, fermentation and starch gelatinization occur with the help of water (Delcour and Hosney, 2010). Water is responsible for many chemical and physical properties occurring in bread formation (Schiraldi and Fessas, 2012).

Medium hardness water (120-180 ppm) gives desirable dough as soft water weakens the gluten during mixing and fermentation resulting in sticky dough with poor gas retention. Jimenez-Maroto et al, (2013) offered a corrected measure to soft water problem by altering the percentage of salt in the formula. He suggested addition of mineral yeast food in the formula. Water molecules can be chemically bound to sugars, starches, salt or other molecules with hydrophilic binding sites thus helps in improving shelf life of bread by lowering its water activity (A_w) level (Seanton and Zeghal, 2001). 0.96- 0.98 was reported as acceptable A_w for bread.

2.4.4 Salts

Sodium chloride (salt) plays a functional role in bread production. It regulates fermentation, produces good dough and texture through strengthening of gluten (Lynch et al, 2009; Placido et al, 2012). It controls yeast action, prevents the growth of wild yeast and bacteria, a whiter crumb is produced and last but not least, it brings out the taste and flavour of bread. The presence of salt is significant in bread staling (Lynch et al, 2009). Salt is hygroscopic

in nature, too little salt causes the dough to ferment too fast and wild while too much salt slows down the fermentation process.

The trend towards decreasing salt in bread production is due to the relationship between salt and health. Salt has been reported as contributor of coronary heart disease (O'Donnell et al, 2012; Poutanen et al, 2014). Jimenez-Maroto et al, 2013 achieved a 40 % reduction of salt in white bread without affecting saltiness. A reduction of salt from 1.2 % to 0.3 % success was attributed to Lynch et al, 2009 without technological difficulties in bread produced.

2.4.5 Sugars

Sugars impact sweetness and enhance flavour in baked products and are being added to dough either in the forms of glucose, fructose, sucrose, honey, and molasses. The main function of sugar in bread making is to provide a substrate reaction for yeast, which in turn produces carbon dioxide. The sugar in bread dough comes either from flour through breaking down of starch into sugar by enzymes present in the flour or added directly to the dough. It is used by yeast at the early stages of fermentation, enzymes in flour releases sugar for gas production and crust colour formation. Sugar is used as antistaling because it delays recrystallization of starch.

Being hygroscopic, sugar helps to retain moisture in bread. It effects fermentation and interfere in dough strengthening process (Mariotti and Alamprese, 2012), it contributes to the golden brown outer crust colour of bread and impacts bloom to the bread and other baked goods (Eat right, 2012).

2.4.6 Lipids

Lipids (shortening) are useful in bread making; they improve dough-handling process, allow a tenderized texture, improve sensory attributes and are used as antistaling agents to prolong products' shelf life. Any fat used in baking is referred to as shortening because of its action of shortening gluten strands. It functions well in the crumbliness of bread structure.

2.5 Principle of Bread Making

As reported by Della Valle et al (2014), bread production processes for baked goods generally follow the same order:

- 1) Mixing of milled grain products with liquid and other raw materials.
- 2) Preparation of dough or batter by kneading, mixing or whipping.
- 3) Leavening of dough or batter by gases.
- 4) Thermal conversion of the dough or batter into a solid baked good that can be cut and chewed after cooling.
- 5) Sluimer, 2005 proposed a serial process of producing bread as: mixing and kneading, dough division, shaping, fermentation, baking, cooling and wrapping.

2.5.1 Mixing

There are three phases of mixing, homogenization of the ingredients, formation of dough and dough development (Della Valle et al, 2014). Incorporation of ingredients and gluten development are achieved by mixing process.

Air cell formation that gives support and firmness to baked loaf, starch and proteins hydration, and activation of yeast after reacting with water as well as oxidation for gluten development occur during mixing. During the mixing of the dough, an early event involves hydrating dough components. The amount of sugar and salt and sugar flour dough, influences gluten hydration and thus determine mixing times (Mariotti and Alamprese, 2012).

2.5.1.2 Autolyse: Improved Mixing

Autolyse is an improved mixing technique that occurs when flour and water are allowed to mix and rest before adding other ingredients especially salt in bread processing. It is a technique developed by Professor Raymond Calvel in 1960s (Raymond, 2001; Gisslen, 2013). It activates protease thus enhances proteins hydration, initiating gluten development and the natural action of amylase begins degradation of starch into simple sugars.

Generally, autolyse decrease dough strength and thus improve dough extensibility leading to production of good quality bread with creaming crumb and excellent flavour. This earlier process of gluten development and starch degradation reduces kneading time and therefore prevent over-oxidation of dough (Gisslen, 2013).

2.5.2. Fermentation

Fermentation can be defined as the breakdown (or decay) of organic substances by yeast, bacteria, or molds. Fermentation of bread dough begins as soon as flour, water, and either yeast or bacteria are all exposed to one another. The stages of fermentation are proofing, second or final proofing and oven spring. Bulk fermentation commences after mixing, final

proof is the period of fermentation after shaping in which the loaves are allowed to grow in size to much of their potential before they are placed in the oven.

Bread made with manufactured yeast usually proof between 45–90 minutes, the remaining period of fermentation is the interval between the insertion of loaves into an oven and the time the yeast cells die from the rapidly increasing loaf temperature.

2.5.3 Proofing

Proofing is defined as the period of fermentation between the shaping of bread loaves and loading of the loaves into the oven. The main purpose of proofing is to inflate loaves with enough CO₂ to maintain their light texture and attractive appearance as they are baked. Common problem in bread making are over proofing and under proofing.

Over proofing occurs due to long fermentation period causing the dough not to be able to withstand any more gas pressure. It results in coarse texture and some loss of flavour. Under proofing describes the condition of a dough with much gas pressure and potential for growth. It is under ripe because of either insufficient time or unbalanced temperature and yeast quantity. Under proofing results in poor volume and dense texture.

2.5.4 Baking

Baking like all forms of cooking is a process of transformation. It is the process of converting raw bread dough through intense heat so its starches, proteins, and other organic compounds change from their original state into a more appealing edible form (Therdthai

et al, 2002). Baking is associated to the level of sugar present in the dough, temperature and duration of baking (Shittu et al, 2007).

Starch gelatinization, protein coagulation, moisture escape, crust formation, browning and oven spring, which is the rapid rising in the oven due to production and expansion of trapped gases because of the oven heat occurring during baking. Maillard browning and caramelization occurring during baking is because of proteins reacting with sugars and sugars breaking down under heat respectively (Dimuzio, 2010; Nielsen, 2010).

Increase in temperature enhances enzymatic activity and favours yeast growth resulting in oven spring (Therdthai et al, 2002). Baking temperature is a function of time and environment ranges between 180 °C and 250 °C (Dooshima et al, 2014; Gomes-Ruffi et al, 2012; Lynch et al, 2009).

2.6 Staling

Staling is the change in texture and aroma of baked goods due to a change of structure and loss of moisture by the starch granules. Stale products are firmer, drier, and more crumbly than fresh products. Staling decreases consumer acceptability therefore results in reduction of income. Bread firming is one of the most obvious and important manifestations of bread staling and hence the criterion for bread keeping quality.

Staling manifests as increase in crumb firmness and crumbliness, deterioration of flavour, and aroma (Mohamed et al, 2010) and loss of crust crispiness. Various methods and techniques used in measuring staling in bread are measurement of crumb firmness, taste panel evaluations and changes in the physical and chemical properties of the starch.

Changes in the starch amylopectin are considered the major factor responsible for firming and other changes in the breadcrumb during storage; incomplete gelatinization and retrogradation of starch expel moisture, resulting in dried texture (Fennema, 1996; Lynch et al, 2009; Mariotti and Alamprese, 2012; Mohamed et al, 2010). Consequently, many researchers have attempted to use the changes in the starch to follow the bread staling process. As staling progresses, there is reduction in amount of soluble starch available in breadcrumb until the starch becomes less susceptible to enzymatic attack. The various components present in wheat flour which eventually become the constituents of bread play an important role in bread staling.

Storage temperature is another important factor to be considered in discussion of bread staling (Mohamed et al, 2010). Staling becomes more rapid as the temperature of storage is reduced. It is generally believed that flour with higher protein levels produce bread that stale at a slower rate. The effect appears to be due primarily to a dilution of the starch rather than a direct effect of protein (Lynch et al 2009).

Bread staling is attributed to moisture redistribution which occurs between components during bread storage. The use of higher protein flour with higher water absorption and the importance of storage temperature have been proposed to retard firming in bread (Gisslen, 2013; Lynch et al 2009; Mohamed et al, 2010).

2.7 Textural Attribute

Texture is the response of the tactile senses to physical stimuli and is related to crispy and crackly feeling. Quality bread is expected to have a soft, tender, smooth and moist mouth

feel with an elastic and cohesive crumb that exhibit a declined adhesiveness (Selomulyo and Zhou, 2007; Upadhyay et al, 2012). Another important attribute of fresh bread is softness. Bread softness reduces during storage; there are changes in taste, aroma, texture and subsequently staling (Eriksson et al, 2014).

2.8 Sensory Quality

Quality can be defined as combinations of attributes or characteristics of a product that are significance in determining the degree of acceptability of that product to the consumer. Food quality has been described to involve safety, nutritional value and stability of food over time.

Consumers are the major arbiters of food quality thus the necessity for sensory quality of food product. Sensory quality implies the acceptance of the perceived characteristics of a product by consumers. Therefore, sensory characteristic is regarded as the important variables that determine the acceptability and perceived quality of any food product. Important quality parameters remain appearance, colour, aroma, flavour and texture (Peri, 2006).

2.8.1 Sensory Characteristics of Bread

Fresh baked products are alluring sensory attributes. Fermentation, baking duration, time, processing methods and ingredients used affect sensory output. The flavour produced come majorly from its ingredients such as salt, sugar and fat (Gisslen, 2013; Nielsen, 2010). Fresh bread has a unique attractive flavour, a golden brown crust, and creamy white crumb

(Selomulyo and Zhou, 2007) due to the effect of alcoholic fermentation, maillard reaction and caramelization of sugars during baking.

Yeast level in the recipe contributes to bread flavour. Maillard browning responsible for the formation of a flavoured brown involves reaction of reducing sugars and amino groups (Dimuzio, 2010; Nielsen, 2010). Breadcrumb flavour is influenced by enzymatic and possible fermentation reactions unlike the flavour of bread crust that is affected by heat reactions (Gisslen, 2013).

2.8.2 Sensory Characterization

Sensory analysis aims at measuring food characteristics and assessing the influence of the attributes on consumer acceptability using human perception. All senses organs i.e. the eye, nose, tongue, ear and hand are involved in determination of sensory characteristics of food products. The area of sensory science is growing with new techniques developing in order to obtain better data and generate better results (Peri, 2006). Elia (2011) initiated the idea of standardizing sensory evaluation method of bread. This was proposed to add value and favours bread quality differentiation.

2.9 Water Activity

Water activity (a_w) is useful in estimation of food perishability. Food storability is best predicted by its acidity (pH) and water activity (A_w) level. Bread has a water activity of about 0.95 and a pH of about 5.3 to 5.8, which prevent it from microbial attack.

2.9.10 Health and Nutritional Properties of Bread

Bread supplies a significant portion of the nutrients required for growth, maintenance of health and well-being. It is an excellent source of proteins (Kihlberg, 2004), vitamins, minerals, fibre and complex carbohydrates (Poutanen et al, 2014). However, nutrient content is affected by extraction rate (Dewettinck et al, 2008).

Bread is low in fat and free of cholesterol. It is bulky so it takes longer to digest and is therefore more satisfying and less fattening than the fats, sugars and alcohols commonly consumed in excess. All types of bread are nutritious, and the differences between them in nutritional value are not significant if we eat a balanced diet. White bread has approximately the same carbohydrate and protein content as whole meal bread, as it contains soluble and insoluble dietary fibre, and a good percentage of the whole-wheat nutrients. Substitution of bread for fats maintains the energy we need to get from our diet by providing carbohydrates rather than fats for energy production (Ndife et al, 2013).

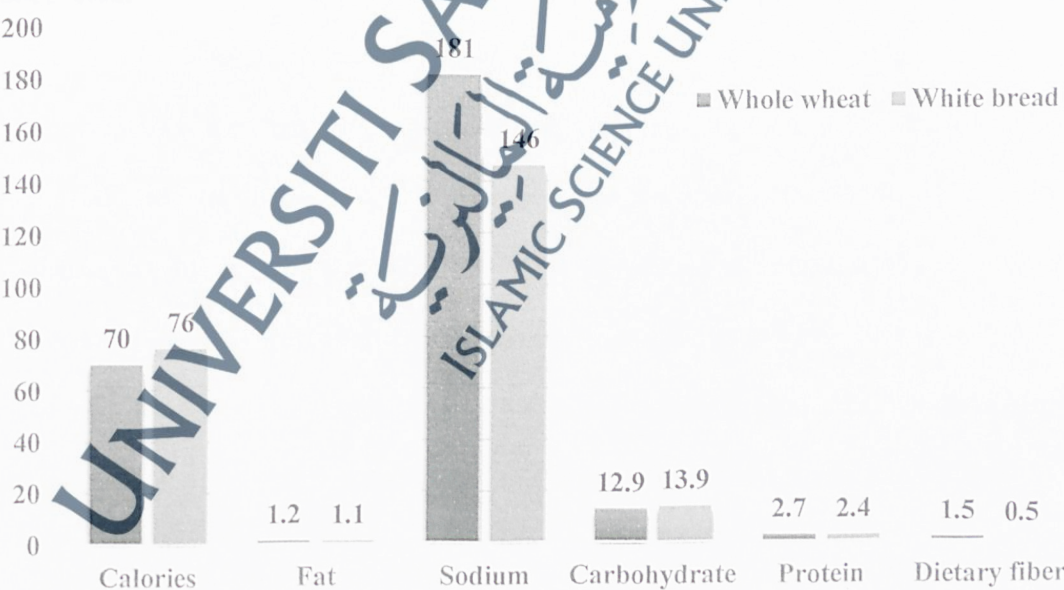


Figure 2.1: Comparison of whole wheat and white bread Source: Dennis, (2012)

Table 2.2: Recommended Daily Allowance of Nutrients

% US Recommended Daily Allowance		
Protein	4.2	3.7
Vitamin A	Trace	Trace
Vitamin C	Trace	Trace
Thiamin	6.7	8.7
Riboflavin	3.5	5.3
Niacin	5.4	6.4
Calcium	2.0	5.6

Source: Dennis, 2012.

Summary

This chapter has presented relevant reported studies with a view to establish the gap left uncovered.