Mini Review
Structural and functional properties of major ingredients of biscuit

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Abstract

Biscuit is a popular food product where it is produced using wheat flour, sugar and fat as its main ingredients. Wheat flour is the major material used in biscuit production and within the flour starch is the principal component. The details of starch properties such as pasting properties, gelatinisation properties, crystallinity were discussed in this review. Starch is the major structural element in many foods, with the fat or sugar also playing key roles. Sugar gives sweetness, colour, add volumes and influence the texture of a biscuit. Besides that, it shows significant impact on starch gelatinization properties. Fat plays an important role in biscuit production and the type of fat used determines the quality of the final product. In this article, the functional properties of major ingredients of biscuit were also reviewed with emphasis on wheat flour, sugar and fat.

Introduction

Biscuit can be defined as a small baked product made principally of flour, sugar and fat (Manley, 1998). It is different from other baked products like bread and cakes as biscuit has low moisture content. Its moisture content is usually less than 4% and thus it has long shelf life, perhaps six months or longer. According to Manley (2000), biscuits can be divided into 10 major types: 1. Bread, pizza and crispbread, 2. Water biscuits and soda crackers, 3. Cream crackers, 4. Cabin biscuits, 5. Savoury crackers, 6. Semi-sweet/hard-sweet, 7. Continental semi-sweet, 8. Short dough (moulded), 9. Wire cut types, 10. Short dough (sheeted). Wire cut types have the highest fat content in their formulation compared to other types of biscuit. Basically, there are two types of biscuit dough; hard and soft. Hard or developed dough is used to make semi-sweet biscuit. Hard dough has high water content and relatively low fat and sugar contents. The dough is hard and extensible (it can be pulled out without immediately broken) (Manley, 1998). The principal ingredients of biscuit dough are soft wheat flour, sugar, fat, and water. They are mixed with other minor ingredients (such as baking powder, skimmed milk, emulsifier, and sodium metabisulphite) to form dough containing a well-developed gluten network. The nature and quantity of ingredients in the dough determine the quality of the biscuit. Several researchers have described the effect of major ingredients in biscuit dough system on the final product (Macche-Rezzoug *et al*., 1998; Chevallier, Colonna, Buleon *et al*., 2000; Chevallier, Colonna, Della Valle *et al*., 2000; Perego *et al*., 2007; Kulkarni, and Joshi, 2013; Blanco *et al*., 2016). The aim of this review is to give a general overview on the structural and functional properties of principle ingredients in biscuit.

Wheat flour

Soft wheat flour is the principal ingredient of nearly all biscuits. It is made of wheat by removing the brown surface coating and the embryo (the bran and the germ) and reducing the particle size of endosperm to a fine powder. Biscuit flours usually have a moisture content of about 14%, protein content (N x 5.7) of about 7-9%, and starch content of about 70-75%. Low protein content flour milled from cultivars of T. aestivum is the most suitable flour for making cakes and biscuits (Hoseney *et al*., 1994). Different types of wheat flour produce dough and final products that have different rheological and baking characteristics (Pedersen *et al*., 2004). Wheat flour differs due to the variety of wheat, growing conditions, planting and harvesting times, etc (Halverson and Zeleny, 1988). The physical and chemical characteristics of flours affect their functionality. The starches, protein, lipid, fat, and sugar also influence the functionality

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of flours.

Particle size of wheat flour

Flours by definition are cereal grains milled to a relatively fine size. However, not all flours have the same particle size range. For example, soft wheat flours are typically ground finer than hard wheat flours because of the softness of their kernels (Figoni, 2008). Particle size is considered as one of the most important physical properties that affects the flowability of powders (Abu-hardan and Hill, 2010). Particles that have smaller sizes have higher cohesiveness properties due to the higher degree of contact area and stronger intermolecular force between particles (Landillon *et al.*, 2007). Higher surface contact area will lead to higher water absorption and higher amount of water needed to produce dough of given consistency. The mean particle size for most biscuit flours is around 50 μm, with less than 10% of the biscuit flours consists of particle size of more than 130 μm (Manley, 2000). Zucco *et al.* (2011) reported that incorporation of fine flours remarkably increases hardness of cookies and decreases spread while coarse flours marginally reduce both parameters.

Starch functionality in biscuit

In dough and finished products, starch acts as filler held in the matrix provided by the other material present. In dough, starch particularly the damaged starch absorbs water. It is probably the main ingredient that controls the amount of water required to produce dough of required consistency (Wade, 1988). According to Kulp *et al.* (1991), starch does not act in cookie systems as a thickener or structure-forming material. They studied the function of starch in cookie baking and found that starch granules remained in their native form during baking. Kulp *et al.* (1991) also reported that starch cannot act as a structure-forming material as it does not gelatinise during baking process and cannot participate in staling by retrogradation. They believed that the structure of cookies must be due to the presence of other components in the flour. Chevallier *et al.* (2000a) characterised starch granules by their susceptibility towards enzymatic hydrolysis (α-amylase). They found that starch granules were intact and birefringent in dough and biscuit surface samples, while some of the starch granules were damaged in biscuit centre samples; some granules had partially lost their birefringence and others were slightly swollen. These findings are in agreement with Chevallier *et al.* (2000b). Most of the starch granules were not gelatinised due to the high level of

sugar in the systems as well as lack of water.

Starch

Starch is one of the most important functional food biopolymers. It is a complex carbohydrate and among the most abundant plant products. Starch is a major food reserve and energy. Starch occurs in all the plants throughout the world. The composition and starch granule morphology vary considerably between and within botanical species, affecting the properties and functions of starches from different crops (Table 1). Starch consists of a mixture of two polymers; amylose and amylopectin (Lineback, 1999). Normal native starches consist of a mixture of 20-30% amylose and 70-80% amylopectin. The physical properties of starch are influenced by the amylose/amylopectin ratio (Biliaredis, 1994; Hoover, 2000; Kim *et al.*, 2006; Kim *et al.*, 2013). Amylose is essentially a linear molecule consisting of α-D-glucopyranose residues linked together by α-(1, 4) bonds, but it also contains a few branches. This has been confirmed by α-amylase degradation followed by gel-permeation chromatography and high performance size-exclusion chromatography of many starches from different sources (Hizukuri *et al.*, 1981; Takeda *et al.*, 1984).

The molecular weight of amylose has been reported to vary between 105 and 106 Da (Hizukuri *et al*, 1989). The degree of polymerisation (DP) is between 100 and 10,000. Amylose from some starch sources contains about 2 to 8 branch points per molecule. The chain length of these branch chains varies from 4 to 100 DP (Hizukuri *et al.*, 1981). Amylopectin is the highly branched component of starch; it is formed through chains of α-D-glucopyranose residues linked together mainly by α-(1,4) linkages but with 5-6% bonds at the branch points (α-1,6) (Buleon *et al.*, 1998). The average size of the unit chains of amylopectin is 20-25 (Hizukuri, 1985). The diversity in the form of starch granules and their molecular constituents influences starch functionality. Comprehensive reviews on the structure of starch are available (e.g Lui (2005); Elliasson (2004)) and fine structure of the macromolecules and granule construction are continuing areas of research (Dundara *et al.*, 2009; Blazek *et al.*, 2009). Table 1 shows starch composition and granule properties of different type of starches.

Starch is unique among carbohydrates because it occurs naturally as granules. Starch granules are relatively dense, insoluble, and hydrate only slightly in cold water. The starch granule is known to be semi-crystalline, and this gives rise to birefringence when viewed under crossed polarised light (Mamat *et al.*,

Table 1. Starch composition and granule properties of different types of starches

Starch characteristics				
Name	Regular Maize	Wheat	Potato	Cassava
Type	Cereal	Cereal	Tuber	Root
Granule shape	Round, polygonal	Round, bimodal	Oval, spherical	Oval, truncated
Granule size (μm)	2-30	1-45	5-100	4-35
Phosphate (%, w/w)	0.02	0.06	0.08	0.01
Protein (%, w/w)	0.35	0.4	0.06	0.1
Lipid (%, w/w)	0.7	0.8	0.05	0.1
Amylose:amylopectin mass ratio[1]	26 : 74	25 : 75	21 : 79	17 : 83
Degree depolymerisation[2]	800	800	3000	3000
Crystalinity[2] (%)	38 - 43	36 - 39	25 - 40	24
Type of crystal	A	A	B	B
Gelatinisation temperature range[2] (°C) and enthalpy (J/g)	62 – 82 / 12.0 – 15.4	53 – 72 / 9.0 – 17.9	56 – 69 / 13.0 – 15.8	52 – 64 / 15.1 – 16.7
Granule morphology[3]				

(Source: Jobling, 2004; [1]Zobel and Stephen, 2006; [2]Pomeranz, 1991; [3]DeMan, 1999)

2010). The semi-crystalline layer consists of ordered regions composed of double helices formed by short amylopectin branches, most of which are further ordered into crystalline structures known as the crystalline lamellae. The amorphous regions of the semi-crystalline layers and the amorphous layers are composed of amylose and non-ordered amylopectin branches (Jenkins and Donald, 1995).

Starch damage in flour

It has been found that in the process of milling, as the endosperm is fractured and then crushed, some of the starch granules are physically damaged, losing crystallinity order. This has a profound effect on the water absorption property of the flour when dough is made as the power of damaged starch to absorb water is about three times that of undamaged granules. In soft wheat flour, damaged starch is typically below 3%. Wheat flour with the lowest possible damage is the most preferred flour as damaged starch has higher susceptibility to the action of amylases during food processing (Sumnu and Sahin, 2008). The level of damaged starch can be measured by incubating a flour sample with α-amylase, followed by measurement of the reducing sugars or glucose that is produced. Hoseney *et al*. (1994) referred to the level of damaged starch as one of the reasons cookies are made of soft wheat flours. Biscuits produced using soft wheat flour showed much greater spread ratios. This is in agreement with Donelson and Gaines (1998) and Barak *et al.*, (2014). They found that higher levels of damaged starch produced smaller biscuit diameters. They suggested that this was due to the damaged starch that increased the dough viscosity by absorbing relatively large quantities of water.

Thermal transitions of starch

The typical phase transitions occurring in starch are the glass transition of theamorphous components, melting of crystallites, and melting of amylose-lipid complexes (Biliaderis *et al*., 1980). Donovan (1979) studied various thermal transitions occurring during heating of starch water mixtures. He found that at high water levels (excess water conditions), one endothermic peak was observed, and it was referred as the gelatinisation endothermic peak. At intermediate moisture content, two separated endotherms were observed. At low moisture contents, this endotherm was shifted to higher temperatures with decreasing water level. In excess water, hydration of theamorphous part as well as melting of crystallites occurs very quickly, whereas at low water contents, both processes occur much slower; therefore, they separate into two distinct peaks in the DSC thermograms. At lower water content, no more water is distributed to the amorphous starch and the melting has to occur at the initial water content. The plasticising effect of water is then low, meaning that the melting temperature of the crystallites is very high (Eliasson, 1980).

Swelling of granules

Most starches are insoluble in cold water and undergo a limited (reversible on drying) swelling due to diffusion and absorption of small amounts of water into the amorphous regions (an exothermic process) (Collison, 1968). When water is added to a starch granule, it enters the amorphous domains of the starch more readily than the crystalline domains. Starch, when heated in the presence of water, undergoes irreversible changes that are dependent on the amount of water and heat available in the

system. Granular swelling has been shown to be influenced by many factors; among them are granular size (Vasanthanand Bhatty,1996), amylose content (Eliasson, 1985; Colonna and Mercier; 1985; Tester and Morrison,1990, 1992; Morrison *et al.*, 1993; Wang and Seib, 1996), starch damage (Karkalas *et al.*,1992; Tester and Morrison, 1993; Tester *et al.*, 1994; Morrison *et al.*, 1994; Schirmer *et al.*, 2013), and temperature (Colonna and Mercier, 1985; Gudmundsson and Eliasson, 1989). The extent and rate of granule swelling when heated in excess water, as well as the characteristic morphological changes that granules undergo as a result of the swelling, are specific to their botanical origin. Cereal starches, for example, are known to swell in two stages (Eliasson, 1985; Elliason, 1986). During the first stage (~60-75°C), granule swelling due to water uptake and the leaching of amylose are rather limited. During the second stage (~75-95°C), extensive swelling and amylose leaching take place (Elliason, 1985; Bowler *et al.*, 1980).

Starch gelatinisation

When starch is heated in the presence of enough water i.e. excess water, starch granules swell, and the crystalline organisation in starch decomposes to form amorphous regions (Atwell *et al.*, 1988). This molecular disordering is called gelatinisation. Granule swelling increases with temperature and becomes irreversible when gelatinisation occurs. As temperature increases, the starch polymers vibrate vigorously, break intermolecular bonds, and allow their hydrogen bonding sites to engage more water molecules. The water penetration leads to an increased separation of starch chains, which has an effect in increasing the randomness and in decreasing the number and size of crystalline regions. Continuous heating results in complete loss in crystallinity (Cauvain and Young, 2006). The swelling corresponds to a mass transfer of bulk water in the suspension to water linked with starch components (amylose and amylopectin). Starch gelatinisation is an endothermic transition, which is well-identified with differential scanning calorimetry (DSC) (Stevens and Elton, 1971; Billiaderis *et al.*, 1980; Cooke and Gidley, 1992; Sopade *et al.*, 2004; Hasjim *et al.*, 2013). This method allows the characterisation of melting parameters i.e. enthalpy of gelatinisation (ΔH) and temperature of melting (endothermic peak temperature) (Douzals *et al.*, 1996).

The transition always involves loss of crystallinity, loss of the birefringence, and hydration of the starch. As long as water is abundant,

gelatinisation will occur at a fixed temperature range, normally 60-70°C. The swollen granules are enriched in amylopectin. The linear amylose diffuses out of the swollen granule during and after gelatinisation and makes up the continuous gel phase outside the granules. Swelling of the granules into gel particles results in an increase in viscosity (Stevens and Elton, 1971; Lelievre and Mitchell, 1975; Donovan, 1979; Biliaderis *et al.*, 1980; Evans and Haismann, 1982; Atwell *et al.*, 1988; Biliaderis, 1998; Hermansson and Svegmark, 1996). DSC, X-ray diffraction (Zobel *et al.*, 1988; Zhang *et al.*, 2013), small angle neutron scaterring (Blanshard *et al.*, 1984; Doutch and Gilbert, 2013), and NMR spectroscopy (Lelievreand Mitchell, 1975; Mendes da Silva *et al.*, 1996) are techniques that have been implemented to study gelatinisation processes. Gelatinisation temperatures and enthalpies associated with gelatinisation endotherms vary between the starches from different sources. The differences in transition temperature between the different starches may be attributed to the differences in the degree of crystallinity. High transition temperatures have been reported to result from a high degree of crystallinity, which provides structural stability and makes the granule more resistant towards gelatinisation (Barichello *et al.*, 1990). The gelatinisation and swelling properties are controlled in part by the molecular structure of amylopectin (unit chain length, extent of branching, molecular weight), starch composition (amylase to amylopectin ratio and phosphate content), and granule architecture (crystalline to amorphous ratio) (Tester, 1997). Granule shape, percentage of large and small granules, and presence of phosphate esters have been reported to affect the gelatinisation enthalpy values of starches (Stevens and Elton, 1971). The variation in energy (enthalpy) and gelatinisation temperature range in starches from different cultivars may be due to difference in amounts of longer chains in amylopectins. Generally, higher amount of amylose will increase gelatinisation temperature. These longer chains require higher temperature to dissociate completely compared to that required for shorter double helices (Yamin *et al.*, 1999).

Loss of crystallinity

Heating of starch in excess water brings about the loss of ordered structure resulting in gelatinisation and eventually loss in structural integrity of the granules. The loss of crystalline order during heating is observed in X-ray diffraction. The water content and the type of starch determine the temperature range during which the crystallinity is lost and the rate at which it is lost (Svensson and Eliasson, 1995). When

the suspension is heated above a certain temperature, water is taken up by the granule thus resulting in swelling. The increased mobility resulting from the swollen region places a stress on the neighbouring crystallites, largely consisting of amylopectin, and the double-helical packing of amylopectin molecules in this region becomes disrupted and crystallinity is lost (Tester and Sommerville, 2000).

Protein content of flour

The amount and type of protein in flour affects the properties of the final product (Macche-Rezzoug *et al.*, 1998; Uthayakumaran *et al.*, 1999; Igrejas *et al.*, 2002; Moiraghi *et al.*, 2011; Barak *et al.*, 2013). Soft wheat flours are typically low in protein content (8-10%) and the proteins are weak in strength, characteristics better suited to making products such as cakes and biscuits (Manohar and Rao, 2002; Mamat and Hill, 2014). Wheat storage proteins have the unique ability to form a viscoelastic network (called gluten) that allows for the production of products such as bread. When water is added to the flour, these wheat storage proteins hydrate to form gluten. The storage proteins that are mainly responsible for the viscoelastic properties of flour are the gliadins and glutenins. Glutenins are large polymeric proteins held together by disulphide bonds. These proteins give dough strength and elasticity. Gliadins are smaller monomeric proteins that are responsible for dough extensibility. Together these proteins form the gluten proteins (Sumnu and Sahin, 2008).

Gluten development

A model of gluten development in dough formation was proposed by Letang *et al.* (1999). At the beginning of dough mixing, glutenins are more or less folded. Some interactions between the molecules can exist, but the overall contribution of these forces is small because of the random orientation of the chains. As mixing time increases, the glutenin polymers tend to align because of the shear and stretching forces imposed. The formation of cross-links between the proteins is then widely enhanced. This large number of interactions between the chains, and due to the fact that all of these forces act together (as a result of the alignment of the molecules), leads to an increase of the dough strength. This behaviour may be compared to one of cross-linked polymers, thus showing a large resistance (high moduli). Excessively long mixing times can lead to the breaking of disulphide bonds holding the polypeptide subunits together; the glutenin proteins are then partially depolymerised (Letang *et al.*, 1999).

Lipids

Lipids are a minor component of wheat and they make 2-4% (weight) of the whole wheat grain. Wheat flour lipids can be divided into free lipids and bound lipids (Pomeranz and Chung, 1978). Both fractions consist of non-polar and polar components. Polar lipids can be divided into glycolipids and phospholipids. Triglycerides are a major component of non-polar lipids. Even though lipid is present only in a small quantity, it has been shown that it has an important and significant role in biscuit making. Semi-sweet biscuits baked from defatted flour are flatter, denser, and harder, and they show collapse of gas cells during baking when compared with control biscuits (Papantoniou *et al.*, 2003). Macche-Rezzoug *et al.* (1998) reported that the effect of fat on dough quality and on the finished product depends not only on their composition, but also on basic flour and on native lipids.

Fats

Fats and oils are essential ingredients in nearly all bakery products. Mamat and Hill (2014) reported that the type of fat significantly influenced dough and biscuit properties. Fats are esters of fatty acids and glycerol that form triglycerides in which three fatty acids are attached to a glycerol molecule (Kaur *et al.*, 2014). The common fats used in bakery products are lard, beef fats, and hydrogenated vegetable oils. Butter, which is a variant of fat products, is used in some premium and specialty products as a texturizer. Butter is also used to add flavour but its high cost precludes extensive use. Cottonseed oil and soybean oil are the most common processed vegetable oils. Corn, peanut, and coconut oils are used to a limited extent. Fats occurring in other ingredients such as egg yolks, chocolate, and nut butters can have shortening effect if the ingredients are present in sufficient quantity. Baking fats may include butter or margarine; both are made of more than 80% fat and also contain an aqueous phase, or they maybe shortening with 100% fat.

The variation in the fat properties such as its melting point and solid fat content has a profound effect on its physical form. Melting point is the transition temperature at which the solid form turns to liquid. Fat with a higher solid fat content exhibits higher melting points, and the wider the spread of the types the various fatty acids involved, the bigger the melting temperature range is (Mamat *et al.*, 2010). Solid glycerides are present as crystals but there is polymorphism so the crystals may not be all the same type. On cooling, the triglycerides molecules can pack together into different crystalline arrangements;

α, β', and β forms. The α form has the smallest crystal size (typically < 2 μm) and the β form is the largest (typically with size in the range of 5-30 μm) (Cauvain and Young, 2006). The β form is the most stable polymorph with the highest melting point. Although the β form is the most stable crystal form, it is not often desired in many food products. This is because β form crystals are generally large and give a sandy texture in the mouth. The α crystal form is often unstable, thus the β' crystal form is often desired in food products.

Fats play many important roles in dough processing and baking (Maache-Rezzoug *et al.*, 1998; Manohar and Rao, 1999; Devi and Khatkar, 2016). In biscuit making, fat is rubbed into the flour. When mixed with the flour before its hydration, the molecules of fat envelop the flour particles and prevent the formation of a gluten network and produce less elastic dough. Any increase in water in the mixture will tend to encourage development of gluten, which will make biscuits hard. Highly elastic dough is not desirable in biscuit making as it shrinks after lamination (Faubion and Hoseney, 1990). Fat also influences the dough machinability during processing, the dough spread after cutting-out, and textural and gustatory qualities of the biscuit after baking (Vettern, 1984). Fat is the principle ingredient responsible for the tenderness of cookies besides keeping the quality, grain, and texture and adding the richness to quality of the cookies (O'Brien *et al.*, 2003). Mechanical properties of biscuits are largely dependent on the fat component of the formulation (Baltsavias *et al.*, 1999). Fat interacts with other ingredients to develop and mould texture, mouth feel and overall sensation of lubricity of the product (Giese, 1996; Stauffer, 1998). Fat also influences the rheological properties of cookie dough (Jacob and Leelavathi, 2007; Mamat and Hill, 2014).

Sugar

Sucrose is a disaccharide, that is, it is made up of two molecules of the basic sugar structure. It plays an important role in the baking process. In addition to sweetness, it also adds volume, tenderness, texture, and colour, and acts as a preservative. However, sucrose is rarely used as the sole sugar in biscuit recipe. Relatively small amounts of reducing sugars, typically 10-20% by weight of the total sugars, are added to most recipes. These reducing sugars are usually added in the form of syrups containing 70-80% dry solids (Wade, 1988). Sugar, depending on the level and type, influences the various rheological characteristics of biscuit dough. Increasing sugar content reduces hardness of the dough, as well as

the development of gluten (Manohar and Rao, 1997; Pareyt *et al.*, 2009). Sugar inhibits gluten development during dough mixing by competing with the flour for the recipe water, resulting in less tough and more crumbly biscuits (Gallagher *et al.*, 2003). Manohar and Rao (1997) and Laguna *et al.* (2013) reported that spread and thickness of the biscuit increase with sugar level. Density as well as compression strength are reduced significantly reflecting improvement in the texture.

Sucrose in biscuit dough dissolves or partially dissolves depending on the amount of water present, and then recrystallises or forms an amorphous glass (a supercooled liquid) after baking, which strongly affects the texture of the baked biscuit (Chevallier *et al.*, 2000a). The quantity of the sucrose present in the dough affects the hardness of the biscuit. The size of the sucrose crystals, and therefore their rate of dissolution as the dough piece warms in the oven, affects the spread of short dough as they bake and affects the appearance and crunchiness of the baked biscuit. As sucrose dissolves during the mixing and baking, it contributes to the liquid phase of the dough to the point where the sucrose solution is saturated, the amount of sucrose depresses the amount of water needed in the dough. Sucrose shifts the starch gelatinisation point to a higher temperature thus allowing the dough to have more time to rise in the oven. Sucrose has been claimed to be an antioxidant in biscuits and thus it contributes to longer shelf life by retarding fat rancidity (Manley, 2000).

The influence of sugar on starch gelatinisation has been studied by many researchers, and it is well-known that gelatinisation characteristics are markedly altered by the addition of sugars (Davis, 1995; Manohar and Rao, 1997; Pareyt *et al.*, 2009). Spies and Hoseney (1982) studied the effect of sugar on starch gelatinisation. They found that increasing the concentration of sugar in sugar-flour water mixtures increased the gelatinisation temperature of starch. Two independent mechanisms were proposed according to the results obtained; 1) the water activity lowering effect (antiplasticiser), and 2) interaction of sugars with starch chains that stabilise the amorphous regions in starch, thus increasing the energy required to gelatinise the starch. The antiplasticising effect of sugar has been explained with a decrease in the free volume, relative to the plasticising action of water alone. The co-solvent, having a greater molecular weight than water itself, is less effective in increasing the free volume and in depressing the glass transition temperature (Tg) of the amorphous material in starch granules. The reduced molecular mobility of the amorphous domain would then result in a higher

gelatinisation temperature (Biliaderis, 2009).

Conclusion

Functional properties of ingredients used in biscuit production show significant impact on the dough and final product produced. Particle size of wheat flour and starch damaged in flour determines the absorption capability of wheat flour and influences the consistency of dough. The amount of protein content present in the flour influences the gluten development in the dough and shows significant impact on the final structure of the product. The presence of fat in the mixture plays important roles during dough processing and baking. Besides lubricating effect, fat also prevents the formation of gluten by coating the starch granules. Less water will be absorbed by starch granules. Sugar influences the various rheological properties of dough and biscuit. Sugar also alters the gelatinisation properties of starch by stabilising the amorphous region in starch.

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