



## Review Article

# Research on the Interaction of Lipid and Main Components in Noodles: A Review

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### Abstract

In recent years, lipids, both in individually or as complexes with components in food raw materials, play an important functional role in foods. Lipids are important functional ingredients in wheat flour, and have significant effects on dough and wheat products. The defatted wheat flour has remarkable change on the physicochemical properties, and the addition of a proper amount of exogenous lipids can improve air holding property of dough, enhance dough strength and stirring resistance. Lipids can also bring good taste, flavor, and improve the structure to the noodles. In this paper, the mechanism of lipid on noodles' quality was discussed during the production of frozen cooked noodles, and laid the subsequent experiment foundation for the effect of lipid on cooked noodles' quality during the process of freeze and preservation influence.

**Keywords:** Lipid; Starch; Protein; Frozen Cooked Noodles

### Introduction

Since frozen cooked noodles have been listed in Japan, the frozen cooked noodles have grown significantly all over the world in the past twenty years. The strong demand for these products that are fresh, healthy, safe to eat and good quality has contributed in particular to the growth of this sector. Moreover consumers prefer frozen ready-meals, because of their long shelf-life [1], and these products can offer better manufacturing, distribution flexibility, safety and extended storage time.

Wheat flour is the main raw material of frozen cooked noodles. The effect of flour on noodles' quality is mainly reflected in the protein, starch, lipids and other major components, whose properties and type of ingredient and processing conditions affect the microstructure of noodles eventually. During food processing, the changes that these macronutrients undergo and the complex interactions between them determine the quality, nutritional, and organoleptic properties of finished food products [2,3].

The objective of this paper is to provide a comprehensive review of lipids in noodles' making by discussing their possible interactions.

### Source of lipids in noodles

#### Lipids in wheat flour

Wheat lipids can be divided into polar and non polar lipids, which can be divided into two groups [4]. In different wheat, the content of non-polar lipid was 0.54%~1.8%, and the polar lipid was 0.11%~0.34% [5]. The free lipid content was 0.1%~1.9%, and the bound fat was 0.2%~2.1%, while palmitic acid and linoleic acid were the major fatty acids in the free lipids and bound lipids [6]. Although the lipids proportion in flour is very small, but its effect on the quality of noodles cannot be ignored. It is generally believed that lipids affect the surface viscosity and cooking loss on the quality of noodles. Baldwin pointed out that the polar oil had an effect on the dough, and improved the gas holding capacity and fermentation property of dough, Promote the formation of dough gluten network [7]. By comparing with the original flour properties, the size of flour by defatted chloroform becomes small

and the dough color more bright. With the remove of lipid, the water absorption become weaker to form dough, and protein network more easily modified [8]. The results show that, the lipids have a significant effect on dough quality.

## **Exogenous lipids**

Flour has little content of lipids, which is better to improve the dough characteristics, often add the flour of natural animal and vegetable oils and fats to dough-making. The addition of vegetable oil or animal fat can improve the mixing and processing properties of dough, strength and the resistance to stirring, and the water absorption rate of dough.

Adding lipids can also enhance the extensibility of the dough, so that the dough has a better uniformity and more closely the internal texture. Ben studied the effect of soybean oil, peanut oil and coconut oil on dough properties, and the result showed that the dough adding coconut oil had mezzo moisture content and good color, the dough adding soybean oil had maximum hardness, and water activity of the dough which added peanut oil increased significantly [9]. Amarjeet made dough by adding 0%, 25%, 75% and 100% millet bran oil instead of shortening, the results showed that the dough got better smooth, and with the millet bran oil content increase, the volume of dough gradually decreased [10]. Jissy Jacob finded that dough by adding sunflower oil had the lowest initial consistency, the best stirring and the highest elongation than that of ordinary hydrogenated oil and butter [11]. The dough of sunflower oil was extended for a longer time, and with relative stable property.

Adding an appropriate amount of exogenous oil can increase the strength, and improve the processing properties of dough. As the intermediate product, the rheological properties of dough have a direct impact on the quality of the finished products.

## **Effect of lipids on noodles quality**

Dahle and Muen Chow have reported that removing lipids from flour can increase the cooking loss of amylose and the viscosity of noodles [12]. Matsuo believes that removing non-polar lipids can increase the surface viscosity and the cooking loss of cooked noodles, increasing non-polar lipids can reduce the surface viscosity of cooked noodles, and adding a certain amount of monoglyceride can reduce the surface viscosity and reduce the cooking loss of noodles [13]. Matsuo also showed that adding right amount of non-polar lipids had no obvious effect on the initial stage of the gelatinization curve, but could increase the peak viscosity of amylose [13]. It is generally believed that the formation of lipid and amylose complex can inhibit the expansion of starch, thus affecting the starch gelatinization and extending the shelf life of the product. Lipid also affected the rheological properties and formation time of dough. Rho have studied the effects of lipid on noodles' quality, and the conclusion is that the surface hardness

of lipids can increase the cooked noodles, on the other hand, polar lipids and glycol lipids will reduce the fracture strength of Hanging noodles, wheat flour, defatted Hanging noodles strength and whiteness increased, fat noodles need less time, shear stress increase cooked noodles, noodles masticatory force increased, surface loss increased [14].

Lipids had a significant effect on the quality of noodle, and the appearance of the noodles could be improved by adding appropriate amount of lipids. Adding different kinds of lipids can affect characteristics of dough, and there are different gluten network structures and abilities of air adsorption in dough. The dough with different plasticity and stability, can improve the cooking quality and shear, hardness and tensile properties of noodles.

## **Lipid interaction in noodles**

### **Interaction between lipids and starch**

Starch is the most important carbohydrate in cereal-based foods, contributing to the characteristics of many foods such as moisture retention, viscosity, texture, mouth-feel, and shelf-life during processing and storage products [3]. The quality attributes of many foods result from the specific pasting, gelatinization and retrogradation of starch, which can be influenced greatly by additives. Complexes between amylose and lipids (fatty acids, lysophospho lipids, and monoacylglycerides) may significantly modify starch properties and functionality; for example, starch solubility is reduced in water, rheological properties of pasta are altered, swelling capacity is reduced, gelatinization temperature is increased, retrogradation is retarded, and susceptibility to enzymatic hydrolysis is reduced [15]. Starch, especially its linear amylose fraction, can interact with endogenous or added lipids to form single helix complexes, which have been well characterized at different molecular levels [16,17]. In the process of cooking and freezing of frozen cooked noodles, oil can form starch fat complex with starch.

Complex formation restricts the solubility and-mobility of amylose. This prevents amylose double helix formation and crystallization [18-20]. From a nutritional point of view, the lipids in starchy food systems affect starch digestibility in the processing of food. On one hand, the presence of lipids slows down the retrogradation of starch, there by inhibiting the formation of resistant starch. On the other hand, the formation of amylose-lipid complex is resistant to enzymatic digestion [21].

The best-known inclusion complexes are amylose-lipid complexes, naturally present in starch and/or formed during gelatinization with endogenous or added lipids [22]. Their importance is reflected in numerous food applications, because they can affect the functional [23], rheological [24], and nutritional properties [25] of the foods. Besides, other fields of science, such

as nanotechnology, helical wrapping of carbon nanotubes [26], and biotechnology [27], study the amylose-complex abilities.

The degree of unsaturation of the aliphatic lipid chain also has an important effect on the thermal properties of the amylose-lipid complexes. The higher the degree of unsaturation is, the lower the thermal stability of the resulting complex is [28,29]. The chain length and degree of unsaturation of lipids have an impact on the thermal properties of amylose-lipid complex [30]. Many authors have described dissociation temperatures of amylose-lipid complexes to increase with the length of the aliphatic chain of the lipid [31,32]. They attributed this to the lower hydrophilicity of longer lipid chains, and the resulting stronger hydrophobic interactions with the interior of the helix, requiring higher temperatures to break these bonds [32]. However, there is a disagreement on the effect of chain length of lipid on the complexing ability. Some researchers suggested that a lipid chain length with 14 carbon atoms is best for complex formation, while others have reported 16 or 18 carbon atoms to be the preferred lipid chain length [33,34]. Retrogradation consists of two separable processes involving amylose and amylopectin. These are the fast gelation of amylose solubilized during gelatinization, and slow recrystallization of amylopectin within the gelatinized granules [35]. Therefore, lipid addition may have an impact this process in two ways. First, amylose-lipid complexation can prevent the co-crystallization with amylopectin. Second, lipids can also complex with the outer branches of amylopectin and, as such, inhibit retrogradation in a more direct way [18,36].

While amylose is well-known to form complexes with fatty acids, there is some experimental evidence which indicates that amylopectin may also interact with fatty acids [37-39]. A good understanding of interaction between amylopectin and lipids and its effect on starch functionality has become increasingly important for food processing and nutrition. A good understanding of interaction between amylopectin and lipids and its effect on starch functionality has become increasingly important for food processing and nutrition.

### **Interaction between lipids and protein**

Proteins and lipids constitute two of the major food components. Their individual contributions to the functional and nutritional properties of foods are well established [40-42]. These two components are also known to affect various properties of foods as a result of their natural interactions. In food technology, the interactions between proteins and lipids occur during the processing of food products such as cheeses, milk creams, mayonnaise, dough, bakery products and several meat products; these interactions lead to formation of 'induced' protein-lipid complexes. In wheat, protein-lipid interactions occur naturally in both of the major components (gliadin and glutenin) of gluten. A specific lipid-binding protein named ligolin was isolated from

wheat; the possible mode of binding of lipids in the gluten complex has been discussed by Laszlit [43].

The protein-lipid interaction in bread dough has been proposed from a model system by Finney (1971) who suggested that the main fractions of gluten (gliadin and glutenin) are involved in these interactions. The polar ends of lipid molecules are bound to gliadin by hydrophilic bonds and the non-polar ends are bound with glutenin by hydrophobic bonds [44]. Some other models have also been proposed to explain the induced protein-lipid interactions which occur during dough formation. There is support for the assumption that the protein-lipid complex is formed by electrostatic interactions between the numerous polar side chains of protein and polar phospholipids and/or glycolipids. More recent studies have confirmed the presence of protein-lipid complexes involving both the major components of gluten.

Interaction between lipids and proteins also affect the organoleptic quality of various foods [45,46]. These interactions take place via several types of bonding and are affected by pH, ionic strength, temperature and other variables in the system. Protein-lipids complexes can also be formed through electrostatic attraction and hydrophobic lipophilic hydrophobic regions. The structural organizations of naturally occurring protein-lipid complexes in biological systems are quite different from those that are formed during processing of food products. However, the physicochemical characteristics of protein-lipid complexes which occur during processing of foods, as a result of processes such as heating, mixing, shearing and storage are quite similar to those of protein-lipid complexes that occur in living systems.

Polar lipids in wheat flour are bound to the gliadin proteins by hydrophilic bonds and to the glutenin proteins by hydrophobic bonds [47]. Lipid-protein complexes were interacted during the process of dough and bread production. The gluten network depends on existence of lipoprotein complexes. Lipids are essential for the expression of protein network. Complexes enhance the rheological properties of dough and increase the gas impermeability and loaf volume [44].

Several studies on dough and on the bread gluten network have confirmed the presence of induced protein-lipid complexes in both gliadin and glutenin. Polar ends of lipids are bound to gliadin by hydrophilic bonds while non-polar ends are bound to glutenin by hydrophobic bonds; the presence of these protein-lipid bonds cement the gluten network and contribute to the structure of the gas-retaining complexes. In dough and bread, the gluten network depends on the existence of protein-lipid complex, which is essential to development of gas impermeability for good gas retention, adequate loaf volume, and also necessary for satisfactory bread structure [44]. Protein-lipid complexes are also known to occur in peanut products particularly during storage of peanut seeds and peanut flour; lipid oxidation produces various reactive

groups which interact with proteins to form different complexes [48]. Soy films and soy milk are also examples of complexes of protein and lipid; the main soybean proteins (7S and 11S) are involved in the film formation and in protein-lipid complexes. Microscopic examination of soy films revealed a structure formed of a continuous protein matrix in which lipid droplets are dispersed [49].

### Interaction among lipids, protein and starch

Binary interactions between starch and lipids have been studied extensively, but knowledge of the interactions among starch, lipids, and proteins, and the microstructure of the complexes is still very limited [50].

### Conclusion

The effect of wheat flour quality on noodle quality has been studied widely and deeply, especially the contents of protein and starch in flour on the relationship. However, the study on the qualities of flour and noodles are mainly based on protein and starch, and the effects of lipids on flour quality and noodle quality are not enough. Therefore, it is suggested that the effects of wheat lipids and exogenous lipids on the quality of noodles should be strengthened. The purpose of this study is to provide theoretical basis for the production of the raw flour of noodles and the production of high quality noodles.

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