

Interactions of Bio-macromolecules During Processing of Instant Asian Noodles: A Review

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The review focuses on how the protein, fats, carbohydrates and water interact and form the complexes during different stages of processing of instant noodles. Moisture is needed for dough formation and chemical interactions therein. Appropriate moisture content is required for proper gelatinization of noodle strand during steaming and eventually moisture is evaporated off by drying and frying to increase its shelf life. Frying oil may undergo degradation process invited by high frying time and temperature, high moisture in oil and polyvalent metals. Various intermediate products like dimers and polymers accelerate the oil degradation finally changing the physicochemical properties of oil rendering it unacceptable for processing. Gliadin and glutenin gives noodle its viscoelastic character. The polymeric glutenin network develops throughout the process of mixing, resting and subsequent stages of sheeting. Protein content and amylose content in noodle are inversely proportional to the oil uptake ratio. Another possibility is the non-enzymatic browning reaction during frying of instant noodles.

Keywords: Instant noodles, Biochemical reaction, Nutritional aspects, Processing, Quality

Introduction

Instant noodles are ready to serve with easy preparation. There are two main types of instant noodles: a) steamed and deep-fried and b) steamed and air-dried pre-cooked instant noodles need only 3–4 min of boiling or rehydration with boiling water to prepare for serving. The frying process removes the water from the noodle strands, resulting in a porous structure that rehydrates quickly when hot water is added.

Asian Noodles can be broadly divided into two classes a) salted noodles and b) yellow alkaline noodles. The most apparent difference between the two types is the addition of alkali (sodium and potassium carbonate). The yellow color of the noodle is due to the chemical reaction of flavones under alkaline condition. Asian noodles are generally made from durum wheat flour (Cuesta, *et al.*, 1993) as it gives superior color and better texture (Fu, 2006). Durum wheat is hard wheat containing high protein. According to (CAC, 2016), durum wheat flour shall not contain less than 11% protein. The gluten protein the elasticity character. Increasing the protein content of flour also contributes to firmness (Karim, 1990).

There is no any approved international standard method for preparation of instant Asian noodles. However, there are basic guidelines as shown in Figure 1, which needs to be followed for maintaining quality characteristics of Asian Noodles.

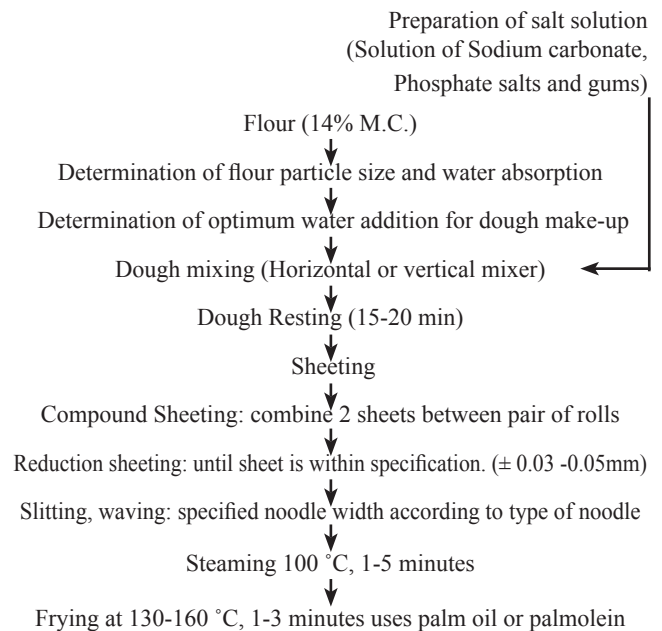


Figure 1. Guidelines for Instant Asian Noodles making process (Ross, 2005)

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Noodles represent a complex system in which multiple components interact to achieve final characteristic product. The interactions or combined effects of water, starch protein and lipid under various conditions are the components of major concern in the processing and product quality of Asian noodles. Dough and noodle quality is affected by wheat proteins (Gary, 2013), starch (Noda *et al.*, 2001), lipids (Lu, *et al.*, 2009), and enzymes (Fu, 2008).

Protein, glycans and lipids are the major bio-macromolecules involved in noodle processing. Bio-macromolecules are the biopolymers formed by joining together small building blocks (bio-molecular monomers) in the cells (Tsai, 2007). There are mainly 3 true macromolecules; carbohydrate, protein and nucleic acid. Lipid is not truly a macromolecule. Monomer constituents of bio-macromolecules are mono-saccharides (for glycans), amino acid (for protein), and glycerol and fatty acid (for lipid). For bio-macromolecules, there is usually a tetrahedral arrangement of bonds around single-bonded carbon atoms and phosphorus atoms. Organic molecules, including bio-macromolecules, are held together with covalent bonds. Their 3D structures are characterized by bond lengths, bond angles and rotations of groups of atoms about the bonds. Covalent bonds are the major source of energy for cells when broken. Computer graphics provides the most comprehensive tool for depicting 3 dimensional structures of biomolecules.

Competition of protein and starch for water during mixing

During dough mixing, proteins, pentosans and starch compete for the limited amount of water available. Since the starch comprises at least 70 % of the flour, it will absorb a substantial amount of the water. Starch which has been damaged in the milling process has an even greater affinity for water absorbing up to three times as much water as undamaged starch (Kruger, 1996).

In Asian noodles, alkali is added in water to increase water absorption and decreases the mixing requirement of wheat flour dough. Larger increase in water absorption is with sodium hydroxide than with either sodium or potassium carbonates (Moss, 1986). Alkali addition also affects the gelatinization properties of starch. For example; sodium hydroxide can gelatinize starch at room temperature (Maher, 1983). Changes in dough properties under alkaline condition have been attributed to oxidation of sulfhydryl-disulfide exchange and oxidation of globulin fraction to form high molecular weight proteins (Terada, 1978).

Alkali can be powder which is also called “soda ash” or liquid form that is termed as “lye water”. In Japan, mixture of sodium and potassium carbonate (*kansui*) are more

common. Optimal firmness for instant noodles is observed with either 0.215% *kansui* or 2.0% NaCl. However, the addition of *kansui* reduced noodle nutritional quality, and high levels of both table (2.03.0%) and alkaline (1.001.5%) salt increased cooking losses (Rombouts, *et al.*, 2014). Powders of black soda are dissolved in water to prepare the solution. The chemical ingredients are dissolved in water (soft water) and stored in storage tank. The pH of the mixing water is maintained at 7.2 – 7.5 at 20°C during storage. Likewise, salt solution is prepared in separate tank and fed into the mixing batch at continuous rate.

In noodle making, incorporation of water with added ingredients is carried out such that actual dough development is minimized. Furthermore, absorption of water is only 29 – 30 percent. The incorporation of water is mainly done to have enough water to hydrate the flour. Less moisture content of dough means that there will be less water to eliminate during subsequent steps of drying and frying. The water absorption is dependent on the type of flour. Water temperature affects mixing time and noodle quality. If water temperature is too low (<18 °C), it slows down flour hydration speed and gluten development and requires a longer mixing time. If water temperature is too high (>30 °C), excessive heat generated during mixing could denature the protein and gelatinize the starch, resulting in sticky dough. High dough temperature can also increase enzyme activity and deteriorate noodle quality. It is recommended that the water temperature be adjusted to achieve a final dough temperature of 25-30 °C (Hou, 2011).

Dough development: lipid, protein and starch interactions

Unlike bread making, dough development is not fully achieved while preparing dough for noodles. In noodle dough, proteins do not pull away from starch granules during mixing. The micro structure resembles that of compacted flour, which is due to the low moisture content of noodle dough (Moss, 1987). During noodle dough mixing, protein absorbs water and forms a limited gluten network, which glues other wheat flour components together, resulting in crumbly dough. Presence of protein-carbohydrate complexes in gluten (McMaster, 1983), binding of lipids to gluten proteins during dough mixing (Bekes, *et al.*, 1983) and implication of both carbohydrate and lipid complex formation with glutenin proteins (Zawistowska, 1985) all directly or indirectly support the possible roles of starch granular proteins and lipids in starch-gluten interactions. Within a dough system, starch exists primarily in granular form, while protein is developed into a continuous three-dimensional network.

Scanning electron microscope studies would indicate that there is some disaggregation and mixing of protein component, largely responsible for dough development, but that is generally incomplete with some vestiges of intact cell components remaining (Moss, 1987). The viscous flow aspect of dough is known to be due to the monomeric gliadin component, whereas the polymeric glutenin gives the elasticity. Gluten is the important gas retaining protein. Concerning the importance of gliadin and glutenin subunits, both aggregate and individual (Kruger, 1996).

Excessively elastic gluten tends to produce a tough dough sheet, which shrinks back during the sheeting process, making it difficult to reduce the thickness and extend the length of the dough sheet, and making noodle strands non-pliable. On the other hand, surface peeling and tearing of the sheet could occur during sheeting through multiple rolls when the rate of gluten development is too slow or the developed gluten network is too small or weak to provide complete encapsulation of flour components. Protein component also determines the firmness of noodle (Ohio, 1985).

Interaction of water on resting

After completion of mixing, dough is allowed to rest to achieve proper distribution of water. Dough is rested in a receiving container while being stirred slowly (5–10 rpm). The stirring helps to dissipate heat inside the dough mass, prevent formation of large dough lumps, and feed dough crumbs into the sheeting rolls in a continuous process.

Resting produces smoother dough sheet as the protein mellows and becomes more extensible. Examination of dough microstructure shows rested dough has more uniform protein matrix and fewer air spaces (Moss, 1987). However, there is no change in the textural properties of adhesiveness, springiness and cohesiveness for noodles processed by superheated steam (Pronyk, 2008). Larger flour particle will take more time to incorporate water and thus having fairly fine particle size is beneficial. The most important thing affecting water absorption is the addition of alkali and salt.

Dough resting is also carried out in sheeting and size reduction as well by slowing down the speed of multilayer conveyor belt which is aided by temperature controlled and relative humidity controlled cabinet. Passing the dough sheets through a series of rolls with reduced roller gaps, gluten is further developed and aligned to the sheeting direction with further encapsulation of starch granules. The microstructure during the compression stage indicates that adjacent endosperm particles become fused together so that the protein matrix within one endosperm particle becomes continuous with that of adjacent particles. However, only a few sub aleurone protein masses show orientation in noodle dough and the fusion of the endosperm particle is

not complete even at the end of the compression stage. The reduction stage which follows further develops the gluten. Uniform protein matrix is obtained at this stage (Moss, 1987).

The development and alignment of the gluten in the dough sheet allows noodle strands to be slit from the dough sheet without breakage or loss of shape during drying, frying and cooking process. Gluten protein content is negatively correlated with cooking loss, and positively with noodle tensile strength and firmness (Hou, 2013). The stage of dough resting helps moisture distribute more evenly. This also enhances disulfide bond formation and forms bond between gluten and lipid. Whether a dough sheet is allowed to rest or not has a significant impact on the degree of starch gelatinization during steaming. According to (Wu, 1998) well-rested dough has a higher degree of starch gelatinization than unrested dough, as examined by differential scanning calorimetric. The lack of evenly distributed water may prevent starch from being fully gelatinized during steaming. Meanwhile, the unrelaxed gluten may suppress starch swelling.

Starch gelatinization and protein denaturation on steaming

Noodles are subjected to steam to partially gelatinize and swell the starch which is needed for fast rehydration rate of the finished product before serving. Starch does not begin to gelatinize until it reaches 84°C even when the moisture is more than 70% (Wu *et al.*, 1998). The starch gelatinization temperature of noodles is therefore even higher than 84°C. Generally, saturated steam is used for steaming the noodles. Drop in temperature results in condensation of steam. To overcome this defect superheated steam can also be used. Superheated steam is the steam with additional sensible heat to raise its temperature above corresponding saturation temperature at given pressure. When processing with superheated steam, noodles dry rapidly and become rapidly cooked. There is also much more gelatinization of starch when using superheated steam than saturated steam (Pronyk, 2008). Steaming denatures the protein and helps to fix the noodle waves. The protein denaturation process usually occurs prior to starch gelatinization because of relatively low moisture in noodles (40% moisture).

Moisture loss during frying

Frying of instant noodles is done at 140–160°C hot oil for 1-2 minutes. During the process, water vaporizes quickly from the surface of the noodle. Dehydration of outer surface of noodle drags water to migrate from the interior to the surface resulting porous spongy structure. These holes serve as channels for water to get in upon rehydration in hot water. Eventually, some of the water in noodles is replaced by oil.

Because the surfaces of fried noodle strands absorb oil during frying, they can easily be separated in hot water. It usually takes 3–4 minutes to cook or soak fried instant noodles in hot water before consumption. The moisture content of the finished noodle products is in the range of 3–7%. The main purpose of frying instant noodle is to remove excess water from the noodles, which causes weight loss accounts for 30–32% of the noodles.

Thermal oxidation of lipid

Series of complex reactions such as oxidation, hydrolysis, isomerization and polymerization take place during the deep-fat frying that influence quality attributes of the final product such as flavor, texture, shelf life and nutrient composition (Zhang, 2012). Saturated fat such as palm oil, beef tallow, vanaspati ghee etc. are used for deep frying of instant noodles in the industry. The reactions in deep fat- frying depends upon factors such as replenishment of fresh oil, frying conditions, original quality of frying oil, food materials, type of fryer, antioxidants, and oxygen concentration. High frying temperature, the number of frying, the contents of free fatty acids, polyvalent metals, and unsaturated fatty acids of oil decrease the oxidative stability and flavor quality of oil. The thermal oxidation rate is faster than the autoxidation. The mechanism of thermal oxidation involves the initiation, propagation, and termination of the reaction as shown in Figure 2.

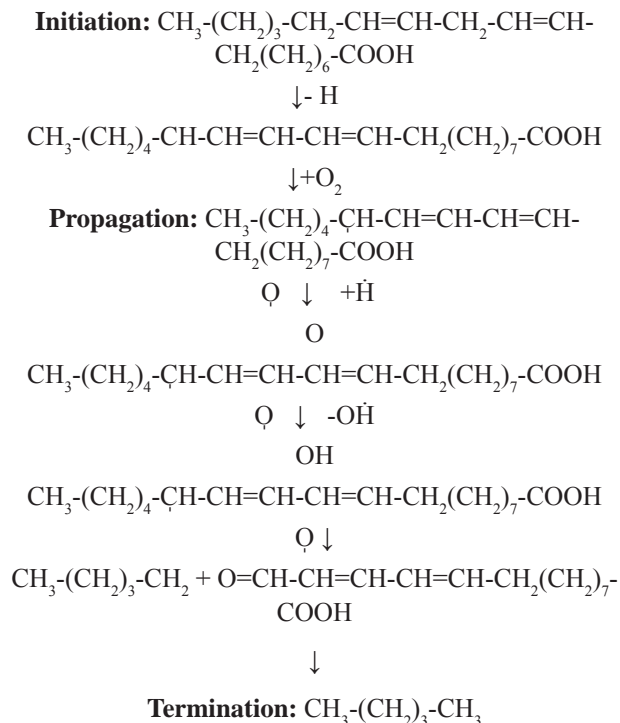


Figure 2. Thermal oxidation of oil (Min, 2007)

Water, steam, and oxygen initiate the chemical reactions in the frying oil and food. Water, a weak nucleophile, attacks the ester linkage of triacylglycerols and produces di and monoacylglycerols, glycerol, and free fatty acids. Free fatty acids contents in frying oil increase with the number of fryings (Chung, *et al.*, 2004). Stevenson and others (1984) suggested that the maximum free fatty acid content for frying oil is 0.05% to 0.08%. Antioxidant decreases the frying oil oxidation, but the effectiveness of antioxidant decreases with high frying temperature (Min, 2007). Antioxidants, Tertiary Butyl Hydroxy Quinone (TBHQ) is mostly used for palm oil and delta Tocopherol for beef tallow. It is well known that TBHQ shows greater stability than Butylated Hydroxy Quinone (BHQ) (Rho, 1986).

Decomposition of ester linkage takes place when water and heat are concomitant to each other (Houhoula, 2003). Thermal hydrolysis takes place mainly within the oil phase rather than water–oil interface (Lascaray, 1949). Hydrolysis is more preferable in oil with short and unsaturated fatty acids than oil with long and saturated fatty acids because short and unsaturated fatty acids are more soluble in water than long and saturated fatty acids. Water from foods is easily accessible to short-chain fats and oils for hydrolysis (Nawar, 1969). Water hydrolyzes the oil faster than steam (Pokorny, 1981). Frequent replacement of frying oil with fresh oil slows down the hydrolysis of frying oil (Romero, 1998) while polymer compounds increases with number of frying as illustrated in Figure 3. Di- and monoacylglycerols, glycerol, and free fatty acids accelerate the further hydrolysis reaction of oil (Frega, 1999). Glycerol evaporates at 150°C and the remaining glycerol in oil promotes the production of free fatty acids by hydrolysis (Naz, *et al.*, 2005). Interestingly, Peroxide value (PV) of frying oil also increases with increasing frying time and temperature (> 180°C) although at low temperature, PV decreases with increasing time of frying oil Figure 4. Radical oxygen requires radical oil for the oxidation of oil. The hydrogen with the weakest bond on the carbon of oil will be removed first to become radical. The various strengths of hydrogen carbon bond of fatty acids explain the differences of oxidation rates of stearic, oleic, linoleic, and linoleic acids during thermal oxidation or autoxidation. The polyvalent metals as Fe³⁺ and Cu²⁺ remove hydrogen protons from oil to form alkyl radicals by oxidation-reduction mechanism of metals even at low temperatures. The site of radical formation in saturated fatty acids is different from those of unsaturated oleic or linoleic acids. The alkyl radical of saturated fatty acids is formed at α position of the carboxyl group having electron-withdrawing property. The high interfacial tension in the frying system breaks steam bubbles and forms a steam blanket over the oil surface. The steam blanket reduces the contact between the oil and oxygen, and lowers the oil oxidation (Blumenthal 1991). Addition of sesame oil can also improve thermo oxidative stability of the frying oil (Chung, *et al.*, 2004).

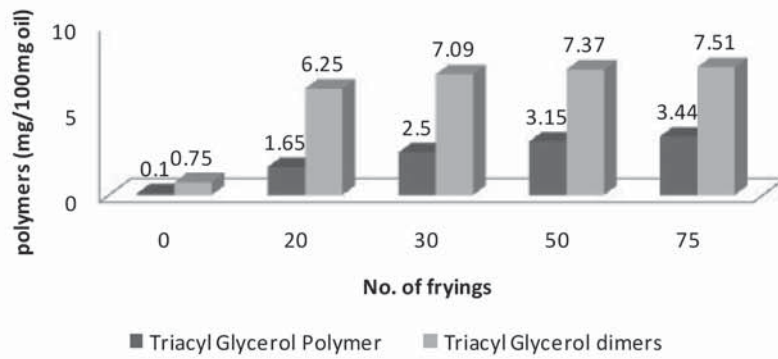


Figure 3. Formation of Triacyl Glycerol Polymers during frying of potatoes (Cuesta, 1993)

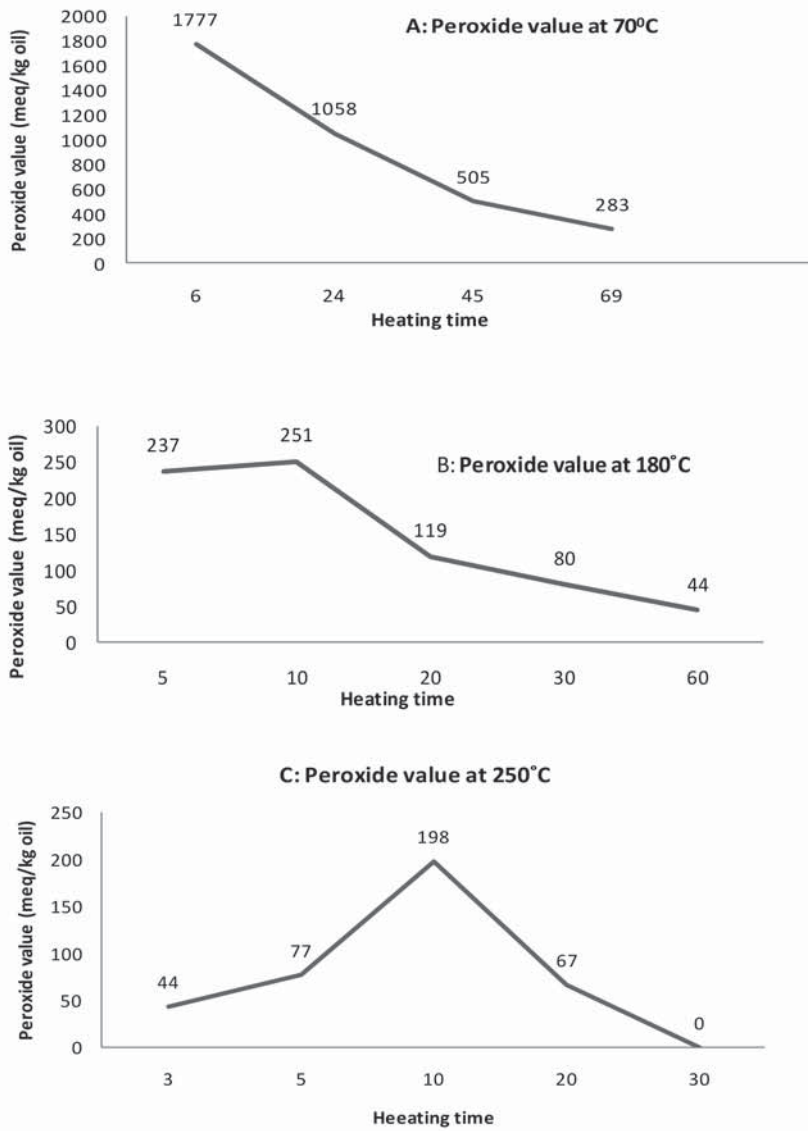


Figure 4: POV of frying oil at different time and temperatures A, B, C (Nawar, 1984)

Rancidity

Rancidity of oil and fat is attributed to autoxidation. These volatile aldehyde compounds have been found to have certain potential threat to health of consumer (Kamal-Eldin, 1996, Seppanen, 2002) especially the genotoxic and cytotoxic properties of unsaturated aldehydes (Guillén, 2008). The genotoxic and cytotoxic olefine aldehyde-contained compounds produced have been reported to be absorbed by the fried material (Seppanen, 2004, Seppanen, 2006). Volatile compounds such as acids, hydrocarbons, alcohols, aldehydes, ketones, esters, lactones and aromatic compounds were detected in separate studies carried out by (Kawada, 1967; Yasuda, 1968; Chang, 1978; Thompson, 1978; May, 1983.) Rancidity of frying oil and fried noodles occurs mainly due to poor storage technique or long storage time.

Formation of polymers

The major decomposition products of frying oil are nonvolatile polar compounds and triacylglycerol dimers and polymers. Dimers and polymers are large molecules with a molecular weight range of 692 to 1600 Daltons and formed by a combination of -C-C-, -C-O-C-, and -C-O-O-C- bonds (Stevenson, *et al.*, 1984; Kim, *et al.*, 1999). Polymerization in deep-fat frying is radical reactions. Allyl radicals are formed preferably at methylene carbons α to the double bonds. Dimers are formed from the reactions of allyl radicals by C-C linkage. Polymers formed in deep-fat frying are rich in oxygen (Tseng *et al.*, 1996). Polymers accelerate further degradation of the oil, increase the oil viscosity, reduce the heat transfer, produce foam during deep-fat frying, and develop undesirable color in the food. Polymers also cause the high oil absorption to foods. The major reaction products formed during deep-fat frying are, oxidized decomposition compounds, hydrolysis products, oxidized TAG polymers, cyclic fatty acid monomers, trans isomers, TAG polymerized products, sterol derivatives, antioxidant alterations, heterocyclic compounds and acrylamide (Zhang, 2012).

Frying: Integrated relationship between of lipid, protein, starch and water

Upon addition of the food to the hot oil, the surface temperature of the food rises rapidly. The water at the surface immediately starts boiling and surrounding oil is cooled down, compensated by convection. As the boiling furthers, the convection is further intensified by the turbulent water vapor. Due to the evaporation, surface drying will occur. The evaporation will also lead to shrinkage and development of surface porosity and roughness (Mellema, 2003). Foods fried at the optimum temperature and time have golden brown color, are properly cooked, and crispy, and

have optimal oil absorption. Similarly, over fried foods at higher temperature and longer frying time than the optimum frying have darkened and hardened surfaces and a greasy texture due to the excessive oil absorption (Blumenthal, 1991). Fat content of instant fried noodles tends to increase as flour protein content decreases while fat absorption of instant noodles tends to increase as starch amylose content decreases (Park and Baik, 2002). The hydrolysis, oxidation, and polymerization of oil are common chemical reactions in frying oil and produce volatile or nonvolatile compounds. The nonvolatile compounds in the oil change the physical and chemical properties of oil and fried foods.

Acrylamide formation

Acrylamide refers to 2-propenamide (C_3H_5NO) which has also been known as, ethylene carboxamide, acrylic acid amide, vinyl amide or propenoic acid amide. Acrylamide appears as a white crystalline solid and the solubilities (expressed in units of g/100mL of solvent at 30°C are: water 215.5, methanol 155, ethanol 86.2, acetone 63.1, ethyl acetate 12.6, chloroform 2.66, benzene 0.346, and heptanes 0.0068. The melting point is 84.5°C and its boiling point is 125°C at 25 mmHg and 192.6°C at atmospheric pressure (Budavari, *et al.*, 1989). Acrylamide is formed when food, particularly those rich in carbohydrate are cooked at above 120°C (WHO/FAO, 2002) especially those prepared by grilling, roasting, baking, frying and deep-frying (Risk Assessment Section, 2003). Acrylamide in the instant noodles ranged from 11.6 to 77.4 $\mu\text{g}/\text{kg}$ (Kawila, 2011). In Noodles, amino compound and aldoses when mediated by high processing temperature may react to give melanoidin, end product of Maillard reaction. The Maillard reaction is exceptionally widespread. It occurs virtually ubiquitously in foodstuffs, particularly during processing at elevated temperatures (Nursten, 2005). Carbonyl compounds produced in the lipid oxidation pathway competes with carbohydrate-derived carbonyls for amino compounds to produce carbonyl-amine reaction products (Zamora, 2011)

Researchers have found that acrylamide possesses neurotoxicity, genetic toxicity and carcinogenicity (Friedman, 2003; Hagmar, Wirfält, Paulsson, & Törnqvist, 2005; Jafari, 2011; Keramat, 2011). Acrylamide is mainly produced by the reaction between some amino acids and reducing sugar on high temperature or during the pathway of maillard reaction (Stadler *et al.*, 2002; Jafari, 2011; Keramat, 2011). Amino acid combined with a dicarbonyl compound and then subjected to intramolecular rearrangement of ion and strecker degradation to form an acrolein, a hydrogen nitride and other compounds or strecker aldehyde (Donald, *et al.*, 2002). Acrylamide is formed from the combination of acrylic acid and hydrogen nitride or ammonium originated from nitrogen containing compounds.

Except the reducing sugar as source of carbonyl compound, some of the lipid oxidation products which occur during deep-fat frying, promote or participate in the formation of acrylamide. The more susceptible to oxidation of the frying oil, the more Acrylamide is formed (Capuano, *et al.*, 2010).

Acrylamide concentration is much higher when palmolein is used as frying oil due to its high content of diglycerides (6 to 8%). This might be attributed to another formation pathway of the amino acid precursor of acrolein (Klostermann, 2002) or formed from glycerol when the frying temperature is higher than the smoke point of frying oil (Claeys, 2005). Therefore, control of the type of frying oil, frying temperature and time are effective to control the producing of acrylamide. Palm oil contains about 45% saturated fat and is more stable than palmolein and other vegetable oils (Fennema, 1985). Among myriad of choices of antioxidants,

such as TBHQ, tocopherols (vitamin E), BHA, or BHT or their mixtures TBHQ is reported to have the best efficiency to prolong the shelf life of fried noodles.

It was found that Maillard reactions generating compounds responsible for smoky taste, aroma and color of foods are coupled with formation of acrylamide from asparagine and reducing sugars (Zhang, 2009). Currently it is clearly known that this compound is also one of triacylglycerols thermal degradation products that is formed during food processing at very high temperature. The intensity of acrylamide formation in foods containing asparagine and reducing sugars depends on initial concentrations of these precursors and their ratio as well as on temperature and duration of thermal treatment, water activity and pH (Shibamoto, 2005; Claus, *et al.*, 2008; Hedegaard, 2008).

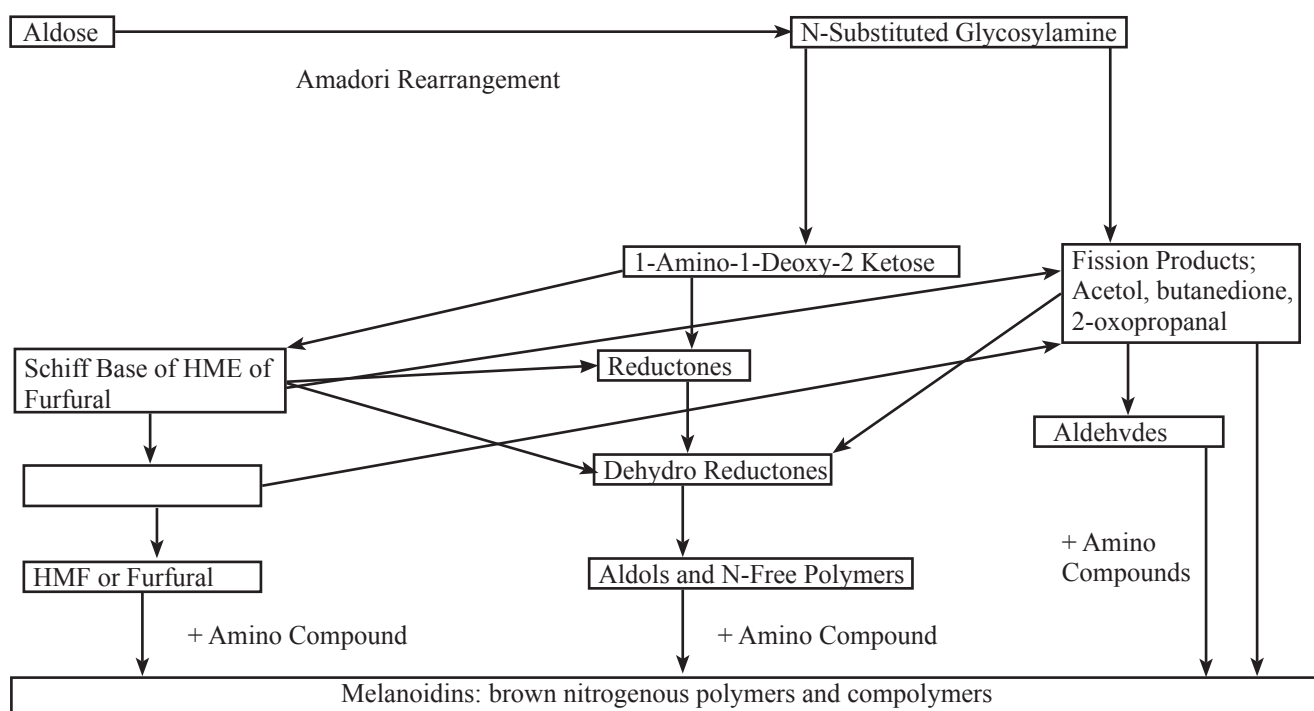


Figure 5. Reaction pathway of non enzymatic browning in food. Adopted from Nursten, 2005.

Traditionally, High Performance Liquid Chromatography (HPLC) and Gas Chromatography (GC) were only used to measure acrylamide quantitatively. Novel analytical technique uses Capillary Electrophoresis (CE), Enzyme Linked Immunological Assay (ELISA) and Electrochemical biosensors. Among these methods, use of biosensors are and ELISA are the most promising one as they allow fast screening of numerous samples without usage of sophisticated apparatus. HPLC, GC and CE are time consuming sample preparation and use expensive equipment (Oracz, *et al.*, 2011).

Noodle color and Noodle darkening

During frying, noodle develops characteristic golden or yellow color. The degree of yellowness in noodles is not only dependent on the alkali used in formulation alone but also on the wheat variety and yellow pigment of the flour (Kruger, 1996). Flavones are colorless at acidic pH and present in great amount in germ and bran. Raw noodle become darker and yellow with time after manufacture as attributed by presence of bran specks and enzymatic browning by polyphenol oxidases (Moss, 1985). Polyphenol oxidases,

tyrosinase, phenol oxidase, phenolase) exist in multiple forms and are concentrated in the bran (Kruger, 1988). The enzymes oxidizes phenols to quinones that turns into dark colored pigments (melanoidins) by self-polymerization and resonance stabilization of aromatic ring structure so formed or by interaction of amino group with proteins. Microscopic examination of noodle shows that most darkening is in the form of spots developing around a nucleus of non-endosperm material (Moss, 1985).

Microscopic imaging of Noodles

Most of the increased understanding of the mechanism of molecular interactions has been brought about by improved imaging techniques. Recently, confocal laser scanning microscopy (CLSM) could be regarded as a potential tool for understanding the effect of processing and the influence on bio- macromolecules. A microstructural change in instant noodles during production has been studied using CLSM to monitor microstructural differences (Dürrenberger, *et al.*, 2001; Lalana, 2001; Sangpring, *et al.*, 2015).

Conclusion and recommendations

Beyond art of just producing noodles out of wheat flour, if we become able to understand physiochemical reaction mechanisms along with different stages of processing, it beneficial not only from economic prospective of industry but also from health prospective of consumer. Acrylamide possesses neurotoxicity, genetic toxicity and carcinogenicity (Friedman, 2003). Consumers are concerned of negative impacts of Maillard Reaction Products (MRPs) on health and their desirability of reducing fat, salt and gluten content of deep fried products obliges food industries to study Several physicochemical changes that take place during processing (gluten network, gelatinization, Maillard reactions, glass transitions). This will lead to discovery beneficial organoleptic properties and color of the crust. Therefore, industries should find intelligent way of utilizing the resources at its optimum. For example: optimum temperature of frying oil, heat supplied, mixing time, steaming time and temperature etc. This will help to save surfeit inputs like steam, heat, frying oil etc. and meet the quality of the product at its highest degree of safety. Thus produced Asian Noodles should have protein (7-10%), fat (16-22%) and moisture (<3%) (Hou, 2011)

However, when looked with meticulous scrutiny, there are myriad of enigmas. Reaction pathway of acrylamide formation is still nebulous and much work to be done on formation of amadori compounds and different polymers formed during frying and its precise detection. Researches can be done to overcome these problems and to have insight knowledge to the perfection.

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