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The Effect of Heat Treatment on Fried Noodle Making

Wan Soo Kim
Department of Grain Science, Kansas State University, Manhattan, KS, USA

밀의 열처리가 라면 제조과정 및 물성에 미치는 영향

김 완 수
캔사스대학교

적 요

95℃ 에서 열처리한 밀가루(Kansas hard white winter wheat flour)로 제조된 라면은 그 제조시 약 38%의 물 흡수율을 보여주었는데 이는 열처리를 안한 control 밀가루에 비하여 약 4~5% 증가함을 보여주었다. 95℃ 에서 열처리한 밀가루는 글루텐이 열에 의해 응고되어 대부분 손상되었으며 α-amylase의 양이 거의 없는 것으로 나타났다. 한편 라면의 가열 전후를 볼 때, 육안으로 본 라면의 색은 상당히 좋아졌는데, 이는 polyphenol oxidase의 불활성화로 인한 것이며, 조리시간도 많이 단축되었다. 조리 후의 라면의 증가된 무게는 control에 비하여 감소하였고, 조리에 의한 손실은 증가하였는데 이는 열에 의해 글루텐 단백질이 응고되거나 손상을 입어 라면 조직의 텍스처가 약해졌기 때문이다. 그러므로 열처리를 한 밀가루로부터 라면을 제조시는, 손상되지 않은 천연의 글루텐(vital gluten)을 첨가하면 국수의 글루텐 단백질과 전분의 결합력을 증가시켜 라면조직을 향상시킬 것으로 보여진다.

I. INTRODUCTION

Heat treatment of wheat or its flour has been studied as an alternatives to chlorination of wheat flour[1-7]. It was suggested that the heat treatment of wheat flour changes in surface characteristic of starch granules from hydrophilic to hydrophobic, which in turn, enhances the interaction of starch granules or with other components such as proteins, and the transfer of water to starch during swelling[4]. Seguchi and Yamada concluded that hydrophobic wheat starch granules bind to the membrane of air bubbles, thus, stabilizing those air bubbles[6]. Heat treatment may split some of the linkages of starch amylose and/or amylopectin chains, resulting in lowering the optimum viscosity of wheat flour, and increase springiness and decrease gumminess in pancakes made from those flours[5]. The effect of heat on gluten proteins has been found to be heat denaturation of gluten protein, that is, loss of tension of the gluten matrix. It was suggested that the denaturation of the protein film on heat treated starch surface could explain the increase of lipophilic properties and that the lipophilic nature of protein film could be disrupted by α-amylase or pepsin but not by SDS.

Heat treated wheat prime starch was found to have more oil absorbed than untreated starch up to 150℃ and up to 2 hours[4]. Although starch granules were not disrupted under weak acidic or alkaline conditions, the surface structure, normally covered with lipophilic sites, was assumed to be disrupted or dissolved. When heat treated starch at 120℃ for 2 hour was treated with 0.2% NaOH, commonly used for extracting the protein from the surface starch, oil-binding capacity was decreased to 1/5, suggesting that protein is related to the oil-binding ability of prime starch. On the other hand, there have been found no relationship between wheat prime starch lipids and oil-binding capacity by using water saturated BuOH (solvent for bound or polar lipids) and $CHCl_3$ CH_3OH (2:1, solvent for whole lipids).

The instant fried noodle, ramen is currently the most popular type of noodle in Asian countries as well as in the U.S.A. In U.S.A., ramen or Oriental noodle soups which are growing rapidly in popularity and now represent about 12% of soup sales, are often marketed as a main dish.

The noodle is a continuous network of gluten protein with starch granule imbedded in the matrix. During cooking, noodle becomes elastic and soft due to a partial denaturation of gluten, a partial gelatinization of starch, and swelling of starch granule with a possible release of some amylose into the matrix. If the effects of heat treatment are likely as above mentioned, the heat treatment of wheat or flour could be beneficial to make fried noodle and it might explain that heat treated wheat flour could make noodle structure even though part of gluten was heat-damaged. In addition, it was claimed that use of H_2O-heat on wheat gives flour that has following advantages: (i) rancidity development low, (ii) color retention good (iii) less susceptible to molds and extended shelf life, and (iv) high nutritional value[8].

In this study, it was attempted to make the fried noodle using flour from heat treated wheat to examine whether the qualities of noodle before and after cooking would be improved compared to untreated, control flour.

II. MATERIALS AND METHODS

1. Materials

Heat treated Kanas hard white winter (HWW) wheat at 203°F (95℃) was obtained from North Regional Research Center, United States Department of Agriculture, Peoria, IL, USA, and milled at Department of Grain Science, Kansas State University, USA, 1991. The flour contained 11.05% moisture, 12.13% protein, and 0.558% ash, which are on a 14% moisture basis (mb). As a control sample, untreated Kansas HWW wheat flour was used, whose moisture content was 11.09%. Protein and ash contents were 12.09% and 0.569 % on a 14% mb, respectively (Table 1). The amount of flour used in an experiment was reported on a 14% mb.

Sodium chloride, petroleum ether were reagent grade from Fisher Scientific Co., Fair Lawn, NJ, USA. Refined palm oil with no synthetic antioxidants was obtained from Palmco Inc., Portland, OR, USA.

2. Analytical Procedure

Protein (N×5.7), moisture and ash content in wheat flour were determined by AACC Approved Methods 46-11, 44-15A and 08-01, respectively[9]. Free lipids in fried noodle samples were extracted with petroleum ether for 16 hours on Goldfisch Extractor using AACC Method 30-25[9].

3. Measurement of Flour Quality

Gluten was washed out on a Glutomatic 2120 (Falling Number, Stockholm, Sweden) using ICC Standard Method No.137[10]. The strength of α-amylase is measured by Falling Number (FN) Apparatus (Falling Number AB, Stockholm, Sweden) using AACC Method 56-81B[9]. All data were reported on a 14% mb. For physical properties of wheat doughs, mixograph, the Brabender Farinograph and Extensigraph were undertaken according to AACC methods 54-60, 54-21, and 54-10, respectively[9]. All assays were done at least in triplicate.

4. Preparation of Fried Noodle

To make fried noodle, the general procedure of Rho et al[11] was sightly modified. Briefly, a noodle dough was prepared from flour and brine solution, rolled, tested, sheeted and cut into noodle strands, which were then randomly placed in a wire-net basket fitted with a lid for steaming for short period of time. Finally, the steamed noodle strands inside basket were deep fried, drained extra oil, cooled and stored at room temperature for further examination (Fig. 1).

5. Determination of Cooking Characteristics of Fried Noodle

The cooking time, cooked weight and cooking loss of fried noodles from untreated and heat treated (203 °F) wheat flour were determined according to Rho[12].

Ingredients

Flour (14% mb)	100
Water	33~38
Salt	1

Procedure

Ingredients
|
Mixing
|
Pass through the rolls (5.5 mm thickness)
|
Resting
|
Pass through rolls of decreasing order of thickness (gap) (sheeting and developing)
|
Cutting
|
wavy shape (shaping)
|
Place noodle strands in a wire-net container
|
Steaming
|
Frying
|
Draining extra oil and cooling for 2~3 hours
|
Instant Fried Ramen Noodle

Fig. 1. General Procedure for Fried Noodle Making.

6. Color Assessement of Fried Noodle Before and After Cooking

Visual color of fried noodle samples from untreated and heat-treated wheat flour was compared before and after cooking.

III. RESULTS AND DISCUSSION

1. Assessment of Flour and Dough Quality

During milling of flour from untreated (control) and heat treated wheat, there was no difference in milling properties between two wheat samples. Proximate analysis showed that protein and ash contents of flours from treated and control Kansas HWWW were not significantly different (Table 1). Contents of wet and dry gluten were determined on Glutomatic equipment using ICC Standard method (No. 137). In control (untreated) sample, contents of wet and dry gluten were 30.42% on a 14% mb and 11.85%, respectively. Gluten from flour from heat treated wheat at 203°F could not be washed out. As it was expected, this was because most of gluten was heat damaged.

In a similar way, heat treatment of wheat killed the α-amylase, which, in turn, renders less liquefying starch gel in the FN determination. More than 400 FN means low enzyme activity. The FNs were 368 and 445 for control and heat treated at 203°F, respectively. Therefore, from the above data, it was concluded that wheat gluten was almost impaired during heat treatment of wheat at 203°F, which agrees with the finding of Finney et al[13]. They studied the effect of drying temperature on chemical, physical and baking properties of preripe wheat, and found that 160°F was a maximum drying temperature without any loss in wheat quality regardless of rate of wheat maturity or wheat moisture level, and that damaging gluten protein from a severe heat treatment is equivlent to reducing flour protein content.

In mixograph study, heat treatment at 203°F gave no signs of developing a point of minimum mobility, and longer mixing time than untreated sample, indicating partially or completely damaging gluten sample due to excessive high drying temperatures. This is consistent with results from Finney et al[13]. In addition, heat treatment of wheat affected the results of Farinogram and the Extensigram. Approximately 60% water absorption for heat treated wheat flour, the dough did not reach to 500 BU (Brabender Unit, consistency) in Farinograph. In the Extensigraph, as expected, the control wheat flour dough showed the increase in height

Table 1. Proximate Analysis of Flour From Control (Untreated) and Heat-Treated Kansas Hard White Winter Wheat

Flour From	Moisture	Protein		Ash	
		As is	14% mb	As is	14% mb
	(%)	(%)	(%)	(%)	(%)
Untreated	11.09	12.50	12.09	0.588	0.569
Heat-Treated at 203°F	11.05	12.55	12.13	0.577	0.558

(resistance to extension) and area (work for stretching the dough) and the decrease in length (extensibility) with time (45, 90 and 135 min).

All three characteristics are related to the gluten strength. However, there was no change in extensibility with time in heat treated wheat flour dough, which is unusual behavior in physical dough tests.

2. The Effect of Heat Treatment on Processing of Fried Noodle Making

Among the noodle-making steps, mixing, sheeting and steaming stages were most critical for final cooked noodle texture. In mixing, water absorption was increased up to 38% for heat treated wheat flour. If the water absorption was less, the noodle dough was too dry and could not make continuous phase after rolled, which required more sheeting steps. If the water absorption was higher, the dough was sticky. In sheeting step, the number of passes into sheeting rolls was not increased because final cooked noodle texture was undesirable. In addition, the same steaming time for control and heat treated wheat flour was used.

3. Quality of Fried Noodles Before and After Cooking

(1) Quality of Uncooked Fried Noodles

Color is an important characteristic of uncooked (freshly made) fried noodle because it is directly related to consumer appeal. Table 2 shows the evaluation of ramen by visual observation. The color of ramen from treated wheat was lighter than that from untreated wheat. This might be due to the inactivation of polyphenol oxidase (PPO) during heat processing, giving the retention of good color during making of product (ramen noodle in our study), which was shown in work of Bookwalter[8].

Texture of fried noodle from heat treated wheat appeared weaker than that from control wheat, due to the heat denaturation or damage in gluten, and easy

Table 2. Quality Characteristics of Fried Noodle Before and After Cooking

	Fried noodle from flour from	
	Untreated control	Treated at 203°F
Uncooked		
Color	Reddish yellow	Brigth yellow
Oil absorbed(%)	24.64	22.94
Cooked		
Cooking time(min)	3 1/2	3 1/4
Cooked weight(%)	228.8	216.4
Cooking loss(%)	11.50	22.47
Cooked color	Reddish yellow	Light yellow (Uniform)
Cooked texture	Slightly chewy, Preferable	Slightly sticky, Too soft and weak texture

detachment of surface starch from enveloping gluten, resulting in less stability of gluten-starch matrix in noodle structure than that of control noodle. This agrees with claims of Doe and Russo[1]. Surprisingly, when the amount of oil absorbed during frying of control and heat treated noodle dough were determined, the control ramen sample was easier to grind for the determination of fat, and had 1.7% more oil absorbed during frying than heat treated one (Table 2). It might be because most of free and/or bound lipids (flour or wheat) were destroyed during heat processing, giving less lipophilic environment for frying. In addition, the interaction between frying oil and the surface molecules in dough might be weak in noodle from heat treated wheat flour. This did not agree with the findings of Seguchi[4], who theorized that heat treatment of flour changes from hydrophilic to lipophilic due to the denaturation of protein film on the surface of heat treated starch. As expected, ground noodle from control wheat flour after defatting showed softer texture and reddish yellow color, compared to that from heat treated wheat flour.

(2) Quality of Cooked Fried Noodle

Results of cooking characteristics of fried noodles from control and heat treated wheat flours are shown in Table 2. Like in uncooked noodle, the color of cooked ramen noodle from heat treated wheat flour was much improved than that from control ramen noodle, whose color became darker with time. This is because most of oxidative enzyme activity (such as PPO) was killed during heat treatment of wheat[8]. In cooking time, 15 seconds was more needed to cook the control ramen noodle than the noodle from heat treated one, because partially denatured gluten in noodle dough, which might have already been transferred from heat treated wheat, could help shorten cooking time. The cooked weight of noodle from heat treated wheat flour was 12.4% lower than that from control one, due to weaker structure from heat processing of wheat. This gave bigger oil drops in cooking water and more cooking loss (about two times) in fried noodle from heat treated wheat flour than that from control wheat flour.

On the other hand, the cooked texture of control ramen was preferred to that of heat treated wheat flour. This might be because too much starch or amylose was exudated into cooking water during cooking, which was important for the major structure of noodle from heat treated wheat flour. Therefore, after heat treatment, the dried functional gluten may be combined with heat treated wheat flour to attach to starch to give strength or structure in noodle matrix.

IV. CONCLUSION

Heat treatment (203°F or 95℃) of wheat denatured most of protein including α-amylase and gluten in the flour. Fried ramen noodle was prepared using flour from heat treated Kansas HWWW and 38% water absorption, which is 4~5% more than that of control wheat flour. Before and after cooking, visual color of fried noodle from heat treated wheat was much improved compared to that from control wheat due to the inactivation of PPO. The cooking time of noodle from heat treated wheat was shorter than that from control wheat. The cooked weight was, however, decreased and the cooking loss in water was increased, in noodle from heat treated wheat, due to heat denaturation or damage of gluten, giving weak texture of noodle matrix. Therefore, it is suggested that after heat treatment, the addition of vital gluten in mixing stage can help the formation of gluten-starch matrix during noodle making.

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