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Research Article

Effects of Layering Milling Technology on Dough Properties of Highland Barley and Bread Qualities

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Highland barley (Qingke) is rich in nutrients and has the nutrient composition of “three highs and two lows,” which are high vitamin, high soluble dietary fiber, high β-glucan, low fat, and low sugar. In this paper, it was proposed to remove the layers of different ratios with different peeling rates. Then, different peeled highland barley was milled into flour and added to bread flour in the same proportion to make wheat-highland barley bread. The results showed that the removal of the cortex of highland barley flour was beneficial to its fermentation characteristics, the comprehensive capacity of gas production and gas holding has been improved, and the maximum fermentation height and retention coefficient were both at QK2-35%, while the gas production at QK4-35% is higher than other samples. From QK0-35% to QK5-35%, the L^* significance of the highland barley bread increased, from 56.31 to 70.88. The results showed that choosing QK4-35% as the best peeling rate of highland barley flour blends could not only retain the nutritional value of highland barley bread but also optimize the quality of bread to a certain extent, which could attract consumers and has a good development prospect.

1. Introduction

Highland barley (*Hordeum vulgare*), known as “Qingke” in China, is a cultivar of hulless barley which grows in Tibet [1]. Highland barley has the characteristics of drought resistance, barren resistance, short growth period, and special plateau adaptability. In local high-altitude areas above 4500 meters above sea level, highland barley is the only crop that can mature normally [2, 3]. The resources of barley varieties are abundant, with thousands of different colors and shapes. According to the number of edges, it can be divided into two-edge highland barley, four-edge highland barley, and six-edge highland barley [4, 5]. According to different colors of highland barley, it can be divided into white highland barley, purple barley, blue barley, black barley, etc. [6, 7]. The structure of highland barley grain is the same as that of common barley. It is divided into husk, aleurone, endosperm, germ, and hypocotyl. The husk is mainly composed of cellulose and hemicellulose, and the germ and hypocotyl are rich in vitamins and inorganic salts [8, 9].

Highland barley, as a kind of coarse cereals, is rich in nutrients, such as, vitamin, soluble dietary fiber, β-glucan, fat, and sugar [10, 11]. Highland barley grain contains an average of 11.37% protein, which is lower than that of wheat and oats but is higher than that of other cereals [10, 12]. It contains 18 amino acids, including 8 essential amino acids for the human body, and lysine can reach 0.36 g/100 g [12–14]. The average content of dietary fiber in highland barley is 20.32%, which is higher than that of corn and buckwheat. Dietary fiber can reduce the absorption of glucose by the small intestine and reduce the starch hydrolysis rate [5, 15, 16]. Different varieties of highland barley have different β-glucan content due to their different growth environments, with an average content between 3.88% and

6.78%, which is higher than that in oats. The consumption of foods with high β-glucan content (β-glucan >3.0 g) can reduce postprandial blood sugar and improve insulin sensitivity, and they are suitable for patients with high blood lipids and high cholesterol [17–19].

Bread is made of wheat flour as the main raw material, added with yeast, sugar, shortening, eggs, etc., after a series of fermentation and molding processes, and then, it is baked. Bread is easy to carry and eat, easy to digest and absorb, and is highly recognized by the public [16, 20]. The rich nutrition and unique flavor of highland barley make it favored by many researchers. Most researchers add highland barley wholegrain flour to wheat flour to study its quality changes, all of which can get the results of the deterioration of dough quality and the poor palatability of products. The addition will increase the nutritional value of the product, but due to the high bran content, the product quality is poor, and it is not popular with consumers [3, 17, 21–24]. The nutrients in grains mainly exist in the cortex and aleurone layer. The particle structure of highland barley is mainly composed of the cortex, aleurone, endosperm, and germ. Therefore, as the peeling rate gradually increases, its nutritional composition will also change [25–29]. In the previous study, we mainly analyzed the impact of different peeling rates on the physicochemical properties of highland barley [26]. In this study, it was proposed to remove the barley layers of different ratios with layering milling technology. Highland barley with different peeling rates was milled into flour, and it was added to wheat flour in the same proportion to make highland barley bread. The impact of the proportion of barley grain flour with varying degrees of hulling in the baking mixture on the fermentation properties and the quality of the dough and bread were assessed.

2. Materials and Methods

2.1. Materials. Highland barley was purchased from Xizang Xinwang Biotechnology Co., Ltd. (Tibet, China). Bread flour was purchased from Jiangsu Nanshun Co., Ltd. (Changzhou, China). β-Glucan kit and total starch kit were purchased from Megazyme Co., Ltd. (Bray, Ireland). Active dry yeast was provided by Angel Yeast Co., Ltd. (Hubei, China). Fluorescein isothiocyanate was purchased from Shanghai McLean Biochemical Technology Co., Ltd. (Shanghai, China). All other reagents were analytical grade products.

2.2. Preparation of Highland Barley Flour and Wheat-Highland Barley Blend Flours. The preparation of highland barley flour and wheat-highland barley blend flours adopted the method described by Zong et al. [26]. The peeling rates of highland barley were 4.59%, 7.20%, 9.22%, 11.15%, and 12.75% after each pass through the flexible peeling machine. The estimation formula of the peeling rate was

$$\text{peeling rate}\,(\%) = \frac{m_1 - m_2}{m_1}, \quad (1)$$

where m_1 represents the weight (g) before peeling and m_2 represents the weight (g) after peeling.

The peeling rates of highland barley flour were 0%, 4.59%, 7.20%, 9.22%, 11.15%, and 12.75%, respectively, denoted as QK0, QK1, QK2, QK3, QK4, and QK5. On the basis of preliminary experiments, highland barley flour with different peeling rates was added to the bread flour in a 35% ratio to obtain wheat barley mixed flour, named as QK0-35%, QK1-35%, Q K2-35%, Q 3-35%, QK4-35%, and QK5-35%. The bread flour without highland barley flour was used as the reference material.

2.3. Determination of Rheological Properties

2.3.1. Farinograph Analysis. According to the Al Ansi method [30] with some modifications, the effect of highland barley flour blends with different peeling rates on the farinograph properties of dough was studied using Brabender farinograph (Duisburg, Germany). 300 g highland barley flour blends were added to the kneading bowl, and immediately (within 25 seconds), water was added. The water absorption, dough development time, dough stability time, and softening degree of the dough were measured.

2.3.2. Extensograph Analysis. The effect of highland barley flour blends with different peeling rates on dough extensograph properties after 45 min, 90 min, and 135 min resting time was determined according to the AACC Method 54-10 [28]. Firstly, different dough types were prepared using Farinograph AT (Brabender, Duisburg, Germany) to achieve a consistency of 500BU. Then, tensile properties were analyzed using Extensograph-E (Brand, Duisburg, Germany). Different dough made from wheat-highland barley blend flours were rolled into cylinders, and we placed them in a test chamber at 30°C for 45 min. Subsequently, their resistance and extensibility were determined.

2.3.3. Rheo-Fermentation Analysis of Dough. The rheofermentation analysis of dough from wheat-highland barley blend flours were determined using a rheofermentometer F3 (Chopin, Villeneuve-La-Garenne Cedex, France) with the method of Omedi et al. [31] with some modifications. The dough was prepared as follows: 250 g flour blends, 5 g NaCl, 3 g active dry yeast, 80% of the water absorption, and then 250 g of dough wheat-highland barley blend flours were placed in the fermentation chamber, and a 2000 g weight was put on the top. The dough was evaluated at 30°C for 3 h. The characteristics of gas generation and dough development were recorded.

2.4. Confocal Laser Scanning Microscopy (CLSM). Dough samples from highland barley flour blends with different peeling rates were treated using the bulk water technique described by Zhang et al. [32] with some modifications. The dyeing agent was prepared by dissolving rhodamine B and fluorescein isothiocyanate (FITC) with dimethylformamide, respectively, preparing 0.1% rhodamine B solution and 0.1% FITC solution, and mixing the two solutions at a ratio of 1 : 1. The dough was cut into 10 mm × 10 mm × 0.7 mm and transferred to a glass slide, and 2 drops of mixed dye were added dropwise to the surface of the dough. After soaking for 10 min, the floating color on the surface was washed away with distilled water and the water was dried in the air for observation under a microscope by using a Fl UOVIEW FV3000 LSCM (Olympus Corporation, Japan).

2.5. Bread-Making Procedure. The preparation of highland barley bread adopted a one-time fermentation method described by Cakir et al. [20] with some modifications. Based on 200 g wheat-highland barley blend flours, the bread formula was 6.0% sugar, 4.0% milk powder, 3.0% shortening, 1.8% active dry yeast, and 1.5% salt, and water was added according to the results of 500 FU powder quality determination. The above mixed substances in the bowl of a needle-type dough mixer (JHMZ 200, Beijing, China) at a low speed for 20 s. Shortening and water was added with a continuous blending at a high speed for about 6 min. After standing for 40 min at 25°C, the dough was fermented for 90 min at 35°C in a proofer with a relative humidity of 85% and then baked in an oven (SEC-2Y, Guangzhou, China) at 190°C for 20 min. The wheat-highland barley bread was cooled for 60 min and stored for further analysis.

2.6. Bread Analysis

2.6.1. Specific Volume of Bread. Specific volume of highland barley bread was measured 24 h after baking using the seed displacement method [33]. The specific volume of highland barley bread (mL/g) was calculated as

$$\text{Specific loaf volume} = \frac{\text{Volume of loaf (mL)}}{\text{Weight of loaf (mg)}}. \qquad (2)$$

2.6.2. The Color of Bread. The color of highland barley bread was measured with a colorimeter (Spectrophotometer CR-400, Konica Minolta, UK) and expressed as color space values using L^* (lightness), a^* (redness) and b^* (yellowness).

2.6.3. Textural Characteristics of Bread. The texture profile analysis (TPA) of highland barley bread was carried out using a TA-XT analyzer from Stable Micro Systems (Guildford, UK) with its Pasta Firmness/Stickiness Rig probe (P/25). The highland barley bread was cut into pieces of 10 mm thickness. The test parameters of the texture analyzer were set as follows: the pretest speed was 1.0 mm/s; the test speed was 1.0 mm/s; the posttest speed was 1.0 mm/s; the trigger force was 5 g; the compression degree was 50%; and the two compression pause time was 5 s.

2.7. Statistical Analysis. All experiments were performed in triplicate except for the fermentation characteristics of dough. The results were expressed as the mean ± standard deviation (SD). The final results were evaluated using SPSS 19.0 statistical analysis software. The significance level was determined to be $p < 0.05$. The statistical analysis was performed using software Origin 9.0 (Origin Lab Co., USA).

3. Results and Discussion

3.1. Effect of the Peeling Rate on Rheological Properties of Highland Barley Flour Blends

3.1.1. Effect of the Peeling Rate on Farinograph Properties of Highland Barley Flour Blends. As shown in Table 1, after adding highland barley flour, the water absorption rate of flour blends increased significantly. While with the increase in the peeling rate, there was a certain decrease, but it only decreased by 0.94%, which was related to the reduction of the bran content of highland barley flour. The results showed that the removal of the bran reduced the water absorption of the flour blends only to a small extent. The development time and stability time of flour blends were significantly lower than those of the control group. The development time increased until QK2 and then started to decrease, while the stability time increased gradually. The softening degree gradually decreased with the increase of the peeling rate, and the softening degrees of QK3-35%, QK4-35%, and QK5-35% were all lower than those of the control group. The farinograph quality number of highland barley flour blends showed a trend of first increase and then decrease, and QK4-35% was the maximum value. The addition of highland barley flour could lead to the softening of the gluten strength of the dough, which is not conducive to the formation of the gluten network. At the same time, the resistance of stirring is reduced and the stability is also deteriorated [34–37].

3.1.2. Effect of the Peeling Rate on Extensograph Properties of Highland Barley Flour Blends. Effects of highland barley flour on the extensographic properties of dough after 45 min, 90 min, and 135 min resting time are shown in Figure 1. The results showed that the area under the extension curve (A) and extensibility (E) of the highland barley flour blends dough were both smaller than those of the control group in Figures 1(a) and 1(b). The results showed that maximum resistance to extension (Rm) and the ratio of maximum resistance and extensibility (Rm/E) of the highland barley flour blends dough were greater than those of the control group as shown in Figures 1(c) and 1(d). Since highland barley flour itself was difficult to form gluten, adding to the bread flour affected the formation and stability of the gluten network structure of the dough, the ductility and viscoelasticity of the dough was reduced, and the extensograph properties of the dough were generally weakened. With the increase of the peeling rate, the area under the extension curve, extensibility, and the ratio of maximum resistance and extensibility first increased and then decreased, and the extensograph gradually decreased. The results showed that the reduction of the bran in the highland barley had a favorable effect on the stability of the dough, and its plasticity has also been improved, which had a certain improvement in the production of flour products.

3.1.3. Effect of the Peeling Rate on Rheo-Fermentation Properties of Highland Barley Flour Blends. As shown in Table 2, the gas holdup rate decreased, indicating that the

Table 1: Farinograph properties of highland barley flour blends.

Samples	Water absorption (%)	Development time (min)	Stability time (min)	Softening degree (FU)	Farinograph quality number
Control	69.85 ± 0.07^{e}	13.15 ± 0.03^{a}	16.08 ± 0.11^{a}	88.00 ± 1.41^{d}	184 ± 0.95^{a}
QK0-35%	77.73 ± 0.04^{a}	8.71 ± 0.04^{f}	7.86 ± 0.08^{g}	117.50 ± 0.51^{a}	121 ± 0.72^{f}
QK1-35%	77.50 ± 0.00^{b}	9.42 ± 0.02^{d}	8.86 ± 0.10^{f}	103.50 ± 0.78^{b}	131 ± 1.12^{e}
QK2-35%	77.29 ± 0.02^{c}	10.18 ± 0.01^{b}	9.27 ± 0.08^{e}	100.00 ± 1.36^{c}	141 ± 0.00^{d}
QK3-35%	77.28 ± 0.03^{c}	9.62 ± 0.02^{c}	10.59 ± 0.02^{d}	86.50 ± 0.37^{d}	142 ± 0.00^{cd}
QK4-35%	77.01 ± 0.01^{d}	9.01 ± 0.01^{e}	11.26 ± 0.02^{c}	83.00 ± 0.00^{e}	150 ± 0.64^{b}
QK5-35%	77.00 ± 0.01^{d}	8.52 ± 0.07^{g}	12.07 ± 0.01^{b}	82.00 ± 0.00^{e}	142 ± 0.82^{c}

Means with different letters within the same row are significantly different ($p < 0.05$).

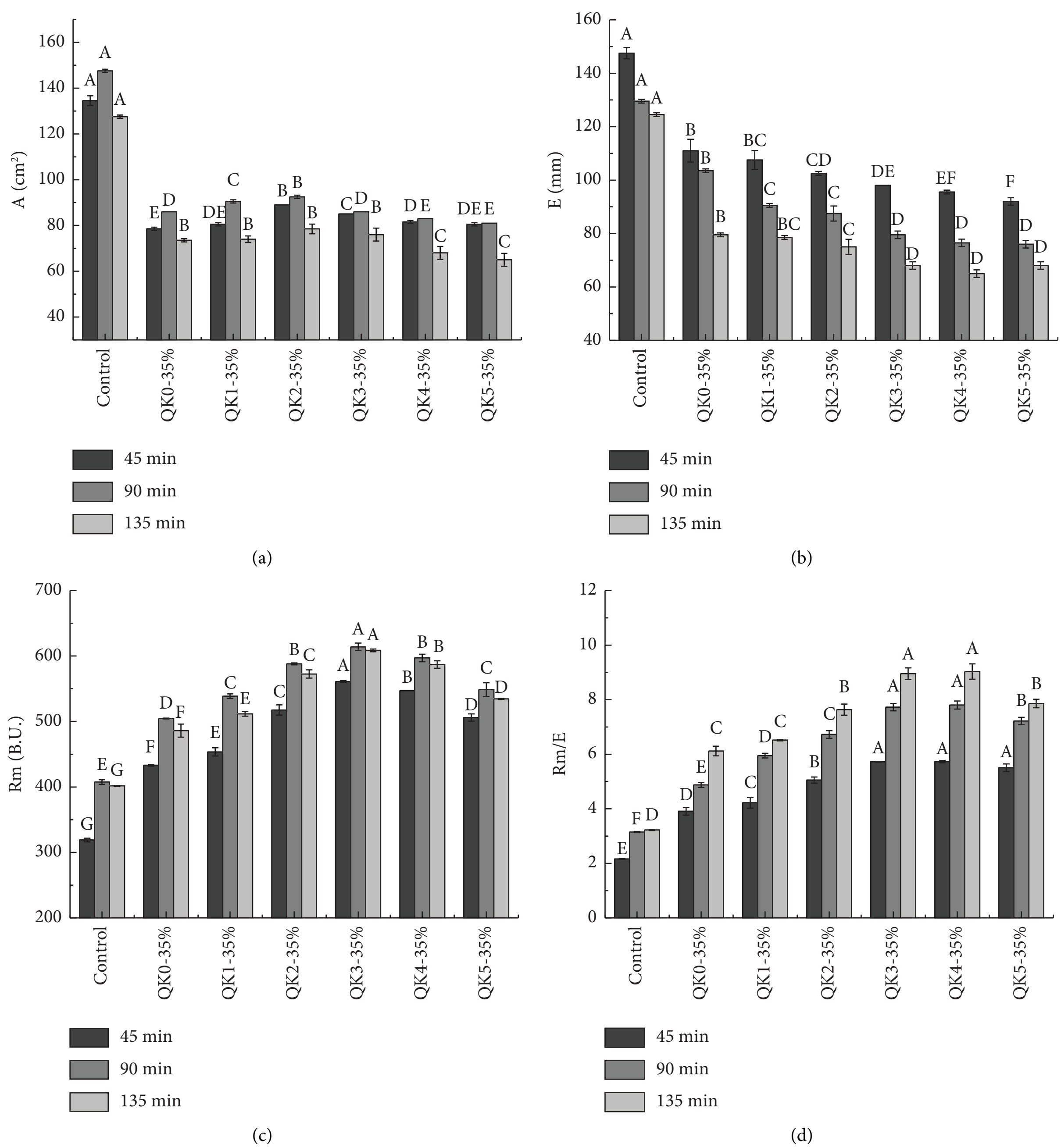

Figure 1: Tensile properties of highland barley flour blends dough after 45 min, 90 min, and 135 min resting time. A, area under the extension curve; E, extensibility; Rm, maximum resistance to extension; Rm/E, ratio of maximum resistance and extensibility.

Table 2: Fermentation characteristics of highland barley flour blends.

Samples	Hm (mm)	Tx (min)	Vt (mL)	RC (%)
Control	60.10	63.00	1668	77.3
QK0-35%	23.10	40.50	1673	70.6
QK1-35%	29.20	48.50	1659	73.3
QK2-35%	30.10	50.50	1631	76.4
QK3-35%	29.10	51.00	1584	76.0
QK4-35%	29.00	48.00	1691	71.5
QK5-35%	29.10	45.00	1646	71.1

Note: Hm, maximum dough fermentation height; Tx, start gas release time; Vt, total gas volume; RC, retention coefficient.

gluten quality of the flour blends deteriorated and the air cells were formed by fermentation. The gas could no longer be retained, and the gas retention of the dough becomes poor. Some studies have shown that the cross-linking of dietary fiber and gluten protein was the main reason for the weakening of its gluten [21, 34]. Compared with the peeled highland barley flour blends' dough, the fermentation characteristics of QK0-35% were the weakest in all indicators. The results showed that the removal of the cortex of highland barley flour was beneficial to its fermentation characteristics, the comprehensive capacity of gas production and gas holding has been improved, and the maximum fermentation height and retention coefficient were both at QK2-35%, while the gas production at QK4-35% was higher than other samples.

3.2. Confocal Laser Scanning Microscopy (CLSM) Analysis of Dough. In order to reveal the microstructure of dough, CLSM is crucial for understanding the interactions and structure-function relationships between dough components [32, 38]. The effect of adding highland barley flour with different peeling rates on the dough network structure has been observed by using the laser confocal microscope in Figure 2.

FITC and rhodamine B stained the starch and protein in green and red, respectively. The yellow or orange-red in Figure 2 was the part where protein was combined with starch granules, and the black part was water, pores, or other substances. In Figure 2, the images A1 and A2 of the control group showed that the dough had a continuous and uniform gluten network structure, and the starch granules were well embedded in it. After adding highland barley flour, larger holes appeared in B1 and B2, which proved from the microscopic aspect that the internal structure of the dough was seriously damaged, and the gluten structure was rough and not continuous and complete. The results were the same as the results of farinograph and extensograph properties. The production of the dough would have adverse effects during the fermentation process. With the increase of the peeling rate, it could be seen from the images of C2, D2, E2, F2, and G2 that the pores gradually became smaller, and the structure of the dough was relatively tight, which was consistent with the cortex. The reduction of substances such as medium fibers was inseparable.

3.3. Effect of the Peeling Rate on the Specific Volume of Highland Barley Bread. Figure 3 is a slice diagram of highland barley bread with different peeling rates. The results showed that compared with the control group, the perimeter of highland barley bread slices decreased and the color became darker. Meanwhile, uneven size holes appear on the slice surface, but with the increase of the peeling rate of highland barley flour, the color of the bread gradually became lighter. It could be seen from Figure 4 that the specific volume of highland barley bread was significantly lower than that of the control group. The addition of highland barley flour with different peeling rates hindered the formation of gluten protein; meanwhile, dietary fiber and other substances could not be decomposed by yeast, which weakened the fermentation process [39]. With the increase of the peeling rate, the specific volume of bread did not change significantly. Although the cortex of highland barley flour was partially removed, the addition of highland barley flour had a more significant effect on the specific volume of bread.

3.4. Effect of the Peeling Rate on the Color of Highland Barley Bread. The color of bread is an evaluation index for consumers to evaluate the quality of bread, which is related to the quality of raw materials and the baking process [26, 30, 40, 41]. Table 3 shows the measurement results of the core color of the highland barley bread with different peeling rates. The color of the bread in the control group was the largest L^*, the smallest a^*, and the largest b^*. The results showed that from QK0-35% to QK5-35%, the L^* significance of the highland barley bread increased from 56.31 to 70.88. All indicators of QK5-35% were close to the control group, indicating that after a certain cortex was removed, the color of highland barley bread has been optimized. The main reactions that affect the color value are Maillard and caramelization. These reactions are usually influenced by the flour composition or other substances used in bread making, metabolites accumulated during dough fermentation, dough pH value, baking temperature, and time [42].

3.5. Effects of the Peeling Rate on Texture Properties of Highland Barley Bread. Texture properties reflect the quality of bread's tissue structure, softness, and chewing taste through the size of various indicators such as hardness, elasticity, and cohesion [43]. Table 4 shows the effect of the peeling rate on the texture of highland barley bread. The hardness, adhesion, and chewiness of highland barley bread were much higher than those of the control group, and the elasticity, cohesion, and resilience were lower than those of the control group. With the increase of the peeling rate, the hardness, adhesion, and chewiness of highland barley bread decreased significantly. There was no significant change in the hardness of the bread, and the adhesion decreased by 25.98%. There was no significant change in the adhesion from QK3-35% to QK5-35%, and the chewiness decreased by 35.82%. With the gradual increase of the peeling rate, the elasticity, cohesion, and resilience of the highland barley bread from QK3-35% to QK5-35% were not significantly

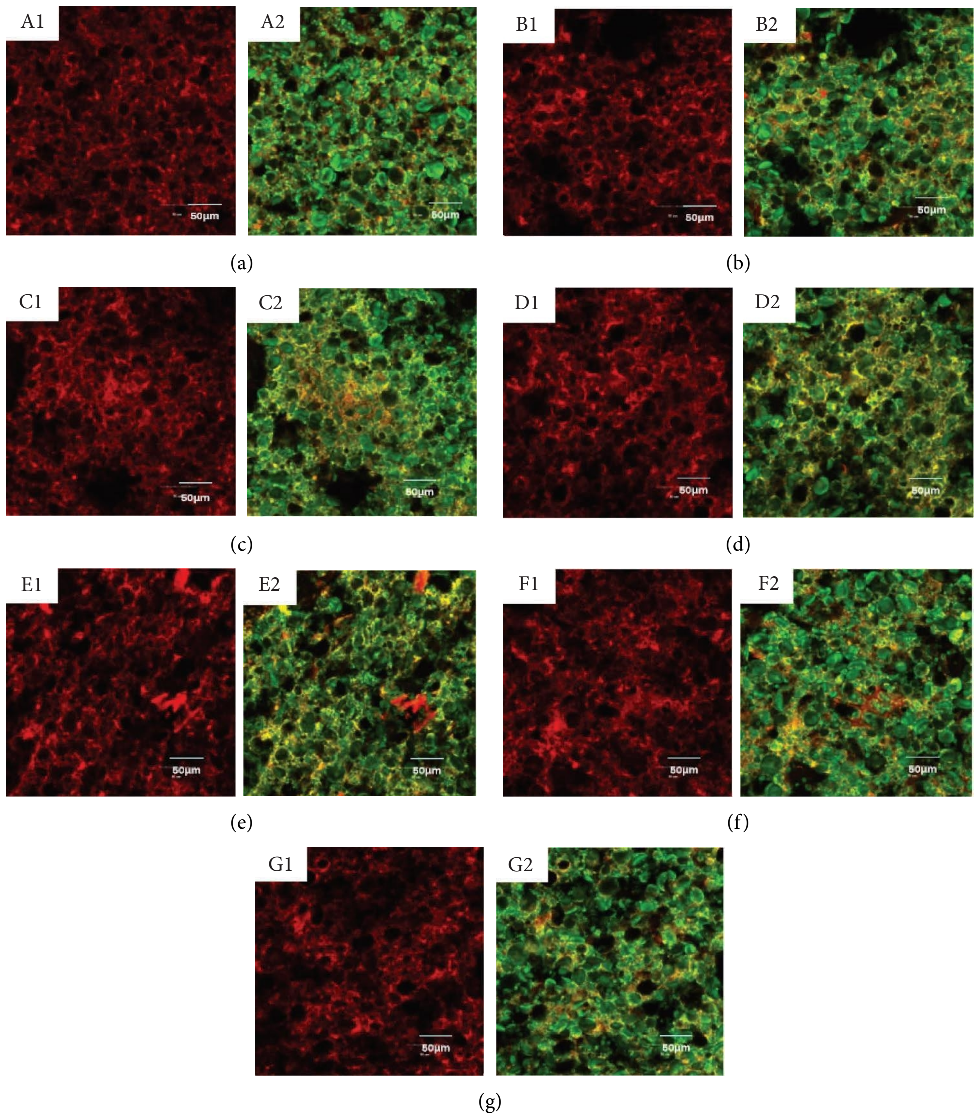

Figure 2: CLSM micrographs of gluten (left, 1) and dough (right, 2). Gluten proteins and starch granules were red and green, respectively; (a) control group, (b) QK0-35%, (c) QK1-35%, (d) QK2-35%, (e) QK3-35%, (f) QK4-35%, and (g) QK5-35%.

Figure 3: Comparison chart of highland barley bread slices with different peeling rates.

changed, and the cohesion was not significantly changed from QK1-35% to QK5-35%. It could be seen from the abovementioned analysis that the peeling rate of highland barley was negatively correlated with hardness, adhesion, and chewiness, but it was positively correlated with elasticity, cohesion, and resilience. The deterioration of the quality of highland barley bread was due to the rough taste caused by the fibers and other substances in the highland barley flour, and the highland barley flour itself was not easy to form gluten, which made the bread's elasticity to deteriorate, there were no uniform and fine pores, and the interior was too tight. After the highland barley flour was used, the hardness, elasticity, chewiness, and resilience of the bread were improved [44, 45].

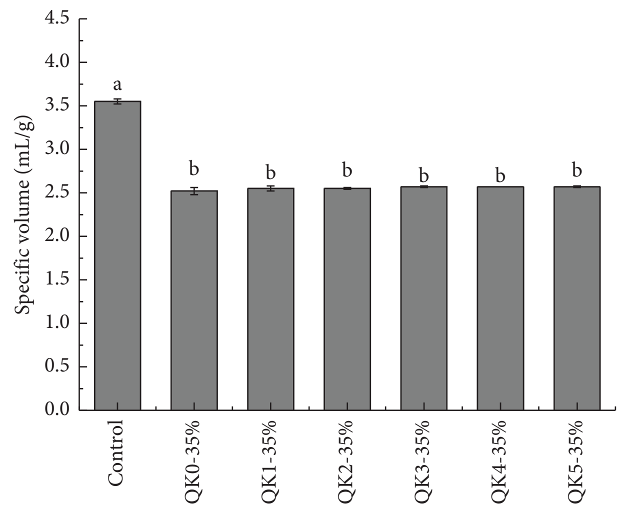

Figure 4: Specific volume of highland barley breads with different peeling rates.

Table 3: Instrumental analysis of the color (coordinates L^*, a^*, b^*, and color difference values-ΔE) of highland barley breads with different peeling rates.

Samples	L^*	a^*	b^*	ΔE
Control	79.67 ± 0.57^{a}	-1.34 ± 0.17^{g}	20.14 ± 0.09^{a}	—
QK0-35%	56.31 ± 0.36^{g}	5.40 ± 0.04^{a}	14.50 ± 0.05^{f}	24.94
QK1-35%	62.39 ± 0.06^{f}	4.34 ± 0.07^{b}	17.37 ± 0.19^{e}	18.44
QK2-35%	65.33 ± 0.05^{e}	3.50 ± 0.01^{c}	17.49 ± 0.13^{e}	15.36
QK3-35%	67.3 ± 0.96^{d}	2.90 ± 0.06^{d}	17.98 ± 0.12^{d}	13.25
QK4-35%	69.37 ± 0.41^{c}	2.24 ± 0.09^{e}	18.50 ± 0.06^{c}	11.03
QK5-35%	70.88 ± 0.23^{b}	1.68 ± 0.04^{f}	19.31 ± 0.11^{b}	9.33

Means with different letters within the same row are significantly different ($p < 0.05$).

Table 4: Texture properties of highland barley breads with different peeling rates.

Samples	Hardness (g)	Elasticity	Cohesiveness	Adhesioness (g. s)	Chewiness (g)	Resilience
Control	391.98 ± 37.63^{d}	0.95 ± 0.00^{a}	0.79 ± 0.01^{a}	1.28 ± 0.71^{c}	290.26 ± 29.68^{f}	0.38 ± 0.00^{a}
QK0-35%	1893.80 ± 68.36^{a}	0.90 ± 0.01^{c}	0.65 ± 0.00^{c}	15.55 ± 2.57^{a}	1396.93 ± 30.11^{a}	0.28 ± 0.01^{c}
QK1-35%	1763.25 ± 35.56^{ab}	0.89 ± 0.01^{c}	0.69 ± 0.01^{b}	14.46 ± 0.24^{ab}	1152.65 ± 24.16^{b}	0.30 ± 0.01^{bc}
QK2-35%	1631.30 ± 94.42^{b}	0.89 ± 0.00^{c}	0.70 ± 0.01^{b}	12.82 ± 1.29^{ab}	1120.27 ± 28.74^{bc}	0.31 ± 0.01^{b}
QK3-35%	1621.14 ± 84.93^{b}	0.92 ± 0.01^{b}	0.69 ± 0.01^{b}	11.50 ± 1.60^{b}	1045.62 ± 74.63^{cd}	0.31 ± 0.00^{b}
QK4-35%	1414.17 ± 19.06^{c}	0.92 ± 0.01^{b}	0.70 ± 0.01^{b}	11.66 ± 1.31^{b}	950.02 ± 48.09^{de}	0.32 ± 0.01^{b}
QK5-35%	1358.55 ± 9.33^{c}	0.92 ± 0.00^{b}	0.70 ± 0.01^{b}	11.51 ± 1.53^{b}	896.58 ± 24.35^{e}	0.32 ± 0.01^{b}

Means with different letters within the same row are significantly different ($p < 0.05$).

4. Conclusion

The particle structure of highland barley is mainly composed of aleurone, endosperm, cortex, and embryo, so as the peeling rate gradually increases, its nutritional composition will also change. Our study reports, for the first time, that the effect of the highland barley peeling rate on dough properties of wheat-highland barley blend flours and bread qualities was studied. In the highland barley flour blends, QK4-35% was ideal for the farinograph properties. The results showed that choosing QK4-35% as the best peeling rate of highland barley flour blends could not only retain the nutritional value of highland barley bread but also optimize the quality of bread to a certain extent, which can attract consumers and has a good development prospect. To retain more nutrients, only a small amount of cortex was removed from highland barley. In subsequent studies, more cortex could be removed and barley-refined flour could be used as a comparison to study the changes in nutrients and physicochemical properties. In this article, the additional amount of highland barley flour was set at 35%. If the proportion of highland barley flour is less, better quality barley bread could be prepared.

Data Availability

The data used to support the findings of this study are available from the corresponding authors upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

Shuangqi Tian acquired the funds, conceptualized the study, performed writing of the review, and conducted the editing of the paper; Jing Lu carried out the formal analysis and investigated the study; Yan Zhang investigated the study, wrote the original draft, and performed the formal analysis; and Zhicheng Chen conceptualized the study.

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