Techniques to Improve the Volume, Texture and Nutritional Quality of Gluten-free Bread

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Abstract

This article highlights the use of soy flour to improve the protein and fiber of gluten free bread. Also, the use of an extrusion process on soybean and corn flour blends improves the volume and texture of the bread. A full listing of the ingredients and method for production of higher quality gluten free bread is included.

Introduction

Individuals with Celiac disease must exclude all prolamin or gluten from any Triticum species. This includes wheat, rye, barley, oats, spelt and kamut. This practice is necessary for continued digestive health. [2]

Gluten free (GF) bread typically has poor quality characteristics such as low nutritional value, low volume, rapid hardening, lack of flavor and grainy texture are common. Also, a high level of fat, sodium and high glycemic index make GF bread unable to meet the needs of the primary consumer. Some of these characteristics can be seen in figure 1. [2]
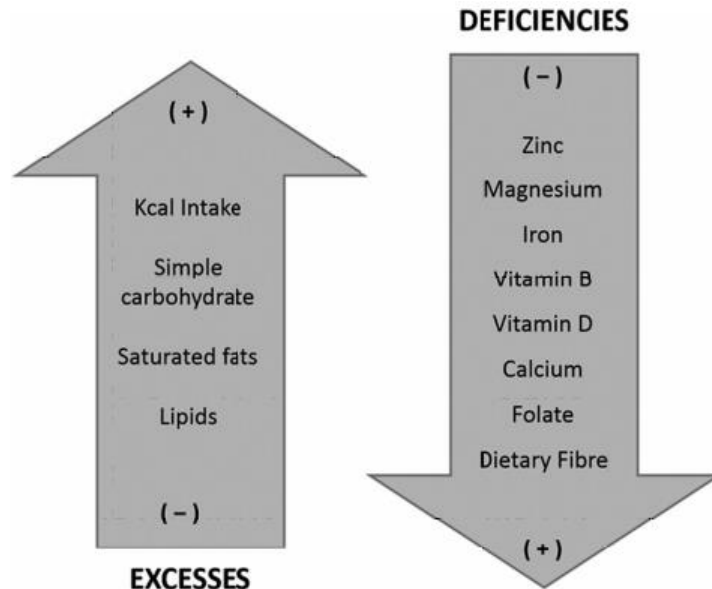
Figure 1. The nutritional value of GF bread compared to nutritional standards. [2]

GF batter can only take the shape of the mold it was placed in since it does not rise. Also, it may have twice the amount of fat as conventional bread to reduce kneading resistance and swelling of starch granules. The process of conventional bread and GF bread preparation can be compared figure 2. [2]
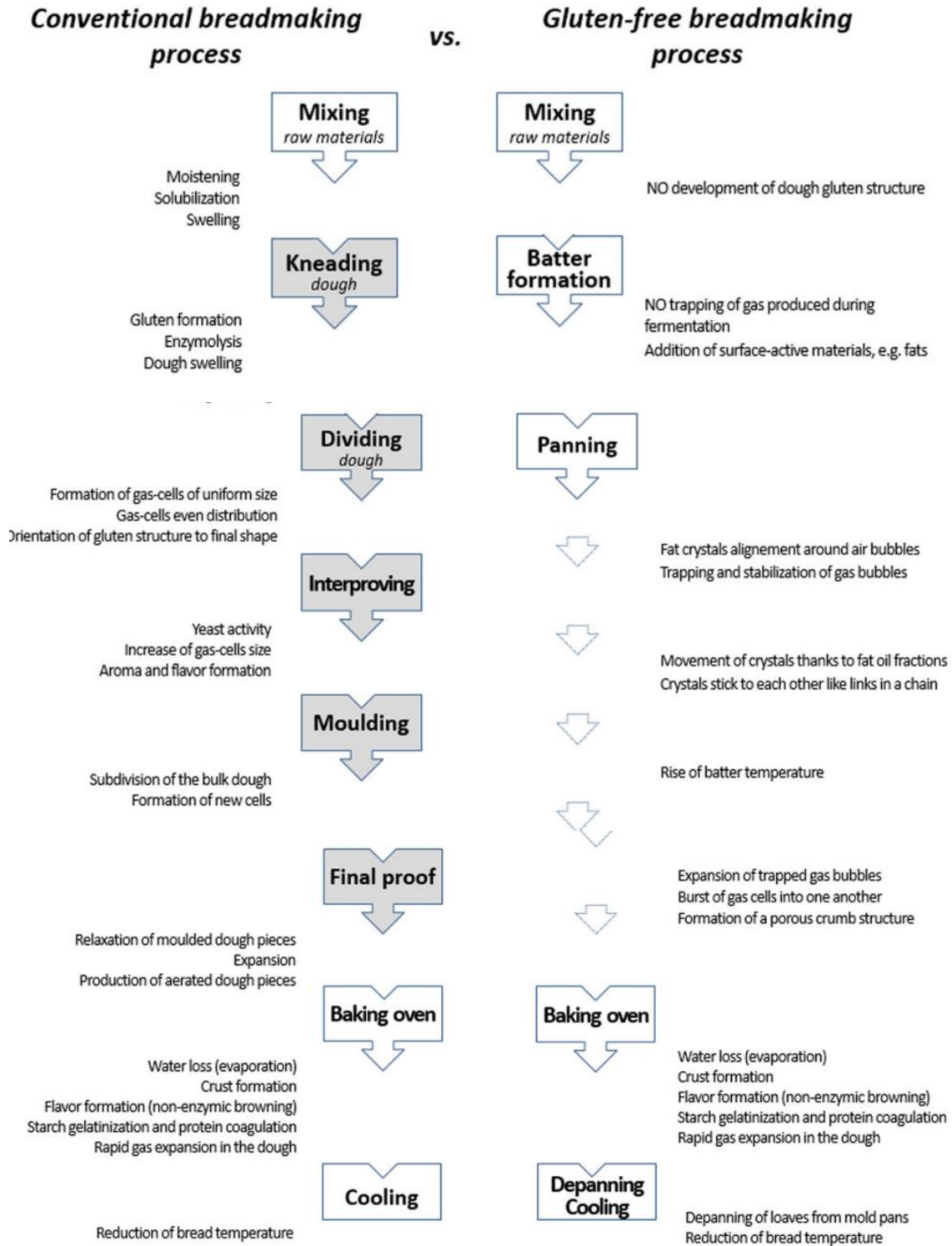
Figure 2. A comparison of the conventional bread and GF bread production process. [2]

Corn, Rice and Soybean Traditional Preparation Bread

The use of a legume-based protein improves the amino acid composition of the bread. Soybean (*Glycine max* L.) is rich in the amino acid lysine, beneficial fatty acids, and dietary fiber. Soybean flour has approximately 4 times the amount of protein as compared to wheat flour. The fiber within soybeans has water binding and gel forming properties that would improve the texture and sensory properties of the resulting bread. The possible disadvantages of using soy are a thickened crust and a bean flavor. [2]

Ingredients: [3]

- Soy flour (40% protein 19% lipid and 85% moisture; this particular flour was produced by Soyan Toos Company, Iran)

- Cassava and corn starch

- Corn flour (4.8% protein, 0.41% ash and 9.6% moisture)

- Rice Flour (9.2% protein, 0.6% ash and 5.7% moisture)

- Sunflower oil

- Sodium caseinate

- Sugar

- Salt

- Yeast (Saccharomyces Cerevisiae)

Production method

Ingredients were mixed with water at 400 rpm for 1 minute and 600 rpm for 2 minutes. [3]

Dough was then divided into 17 parts of 60 grams each. [3]

The dough was then proofed at about 27 degrees Celsius and 80% humidity for 15 to 20 minutes. [3]

Bread was baked at 225 degrees Celsius for 20 minutes with steam.[3]

The loaves were then allowed to cool for a minimum of 2 hours at 24 degrees Celsius before evaluation. [3]

Table 1. Nutritional value of the different gluten free mixtures.[3]

Samples	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Fiber (%)	Carbohydrate (%)	Specific Volume
(Control)	27.9 ± 1.4	9.8 ± 0.44^a	3.3 ± 0.14	1.7 ± 0.25	0.29 ± 0.07	58.3 ± 3.2	2.7 ± 0.19^a
5% soy flour	27.2 ± 2.3	10.7 ± 1.1^a	3.6 ± 0.56	1.8 ± 0.24	0.31 ± 0.12	56.6 ± 1.7	2.6 ± 0.06^a
10% soy flour	26.8 ± 0.10	11.5 ± 0.24^a	3.8 ± 0.07	1.9 ± 0.11	0.35 ± 0.21	55.3 ± 2.2	2.5 ± 0.32^a
15% soy flour	26.51 ± 2.6	12.9 ± 0.26^b	4.1 ± 0.84	2.2 ± 0.26	0.38 ± 0.05	52.3 ± 1.6	1.6 ± 0.06^b
p-value*	N.S	0.03	N.S	N.S	N.S	N.S	0.01

Different letters in the same column indicate significant differences ($p < .05$).
*Over all p-Value for Analysis of variance Test.

Table 2. Sensory evaluation of the different levels of soy flour. [3]

Samples	Taste	flavor	Color	Texture	Overall acceptability
50% Corn flour with 0% soy flour (Control)	4.15 ± 0.81	4.05 ± 0.826	4.25 ± 0.78	3.45 ± 0.51^a	4.25 ± 0.78
45% Corn flour with 5% soy flour	4.17 ± 0.85	4.25 ± 0. 550	4.40 ± 0.786	3.3 ± 0.57^a	3.95 ± 0.82
40% Corn flour with 10% soy flour	4.2 ± 0.83	4.10 ± 0. 718	4.50 ± 0.513	4.05 ± 0.94^b	4.20 ± 0.83
35% Corn flour with 15% soy flour	4.35 ± 0.74	3.95 ± 0 .887	4.55 ± 0.754	4.1 ± 0.85^b	4.45 ± 0.68
p-value*	N.S	N.S	N.S	0.001	N.S

Different letters in the same column indicate significant differences ($p < .05$).
*Over all p-Value for Kruskal–Wallis Test.

The key findings:

- The fat content increased from 3.3% to 4.1% with the increase in soy flour of 0% to 15%. [3]

- Crude fiber increased from 0.29% to 0.38 with the increase of soy flour from 0% to 15%. [3]

- The score of crust texture improved with the addition of soy flour. [3]

- The decrease in flavor score with increased levels of soy flour may be due to the bean taste. [3]

Corn, Rice and Soybean Extrusion Process Bread

Ingredients

- Long grain rice milled and sieved moisture content 10.8% and protein content of 7.3%. [1]

- Corn starch [1]

- Extruded Corn Meal (ECM) 11.9% moisture and 8.1% protein. [1]

- Corn Meal (CM) and Defatted Soy flour (DSF) after extrusion was called blend 1. The Ratio of CM to DSF was 87.5% to 12.5% per 100 g weight (w/w). 8.8% moisture and 11.6% protein. [1]

- CM and DSF with a ratio of 75% to 25% w/w was called blend 2 after extrusion. 8.8% moisture and 11.6% protein. [1]

- Skim milk powder [1]

- Sodium caseinate [1]

- Sunflower oil [1]

- Monoglyceride Dimodan 100/B [1]

- Sugar and salt [1]

- Fresh yeast Saccharomyces cerevisidae [1]

- Hydrocolloids: xanthan gum, Satiaxane Cx-911, guar gum, Emulcoll, pectin, Grinsted LA 410, microcrystalline cellulose, Avicel biopolymer [1]

Production method

1. Rice flour was mixed with corn starch. [1]

2. The corn meal, or corn soy extrusion blend was added at a 1 to 1 ratio per 100 grams. [1]

3. The remaining ingredients, except the yeast, were blended on speed 2 for 30 seconds. [1]

4. The dry ingredients were mixed with the wet ingredients and with the yeast. The resulting dough was placed in a farinograph kneader at 120 rpm for 3 minutes at 30 degrees Celsius. [1]

5. The dough was divided into 80-gram pieces and placed in a bread pan. All dough pans were proofed in a cabinet at 33 degrees Celsius, 80% humidity for 75 minutes. [1]

6. Each dough pan was briefly steamed and then cooked in a 210-degree Celsius oven for 20 minutes. [1]

The Key Findings:

1. The addition of Hydrocolloids improved the water retention, flow, and viscosity of the dough. [1]

2. When the dough was made with extruded corn meal instead of corn starch the water absorption was significantly increased. [1]

3. Dough made with xanthan gum was too firm and released water when mixing. [1]

4. Cellulose and pectin made the dough too sticky. [1]

5. When extruded flours were used, dough volume was increased significantly. The best result was when using guar gum. [1]

In the tables below, the type of dough is described as:

- The standard is a dough that uses only rice flour and corn starch. [1]

- Sample 1 is extruded corn meal. [1]

- Sample 2 was the extruded CM and DSF with a ratio of 75% to 25% w/w. [1]

- Sample 3 is Corn Meal (CM) and Defatted Soy flour (DSF) Ratio of CM to DSF was 87.5% to 12.5% per w/w. [1]

Table 3. Dough and Bread yield with 3% Guar Gum Addition [1]

Parameter	Standard	Sample 1	Sample 2	Sample 3
Dough yield, %	181.9	200.8	205.6	205.6
Bread yield, %	154.1	169.4	171.7	172.2
Volume yield, cm³/100 g	241.7	294.9	353.8	344.5

Table 4. Sensory Evaluation of Bread With 3% Guar Gum Addition. [1]

Parameter	Standard	Sample 1	Sample 2	Sample 3
Volume	8	11	15	13
Crust	15	14	13	10
Colour	10	10	10	10
Crumb grain	10	10	10	10
Texture	12	14	15	13
Aroma	13	15	12	14
Taste	15	20	20	16
SUM (max = 100)	83	94	95	86

Conclusion

The use of soy flour has improved the quality and sensory characteristics of the gluten free bread. When using only traditional methods for the corn, rice, and soy bread recipe, protein and fiber increased while carbohydrates decreased. However, the amount of fat in the product also increased. With each addition of more soy flour the texture of the bread improved significantly.

The extruded flour blends improved the volume, texture, and taste of the bread over the standard gluten free bread. All bread yield characteristics were improved by extruded flour blends.

These results show that gluten free bread can be greatly improved by incorporating soy flour into the dough formula. Also, a processing method such as extrusion can improve the volume and texture of the gluten free bread above the current standard.

References

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