Proceedings of the National Conference
On Undergraduate Research (NCUR) 2017
University of Memphis, TN
Memphis, Tennessee
April 6-8, 2017

Fortification of Sourdough with Lupin Bean Flour to Increase Protein and Micronutrient Content of Wheat Bread

Danielle Morrison DTR
Dept. Human Environmental Sciences
Nutrition and Food Science
University of Central Oklahoma
100 N University Dr.
Edmond, OK 73034 USA

Faculty Advisor: Kanika Bhargava

Abstract

Sourdough is a fermented dough rich in probiotic content, which is known to improve immunity and help with prevention of some chronic diseases, such as heart disease, cancer, and digestive issues. The objective of the study is to formulate, optimize, and perform the consumer acceptability study on the lupin bean fortified sour dough and wheat bread. I hypothesized that creating more nutrient dense flours to sourdough can improve nutrition and quality of bread product. For this project, sourdough was fortified with lupin beans for higher protein, vitamin, and mineral content. The flour mixtures are as follows: 100% all-purpose flour as the control group. Lupin bean used in 50% ratio to all-purpose flour, and 25% lupin with 75% all purpose. The sour dough from different variables was optimized and characterized by physiological testing such as pH and moisture content. Texture and Nutritional quality of the bread was measured using Penetrometer and Genesis R&D software, respectively. Sensory data was collected though a taste testing panel of 50 individuals using a 9 point hedonic scale. The results indicated that pH and moisture content of dough was increased with increase in lupin bean flour concentration. Furthermore, the lupin bean flour created a softer texture product and the rise of the dough decreased with amount of lupin bean present. The Lupin Bean fortified bread will potentially provide a nutrient dense alternative to traditional wheat bread and offer many health benefits.

Keywords: Lupin Beans, Bread, Wheat, Fermentation

1. Introduction:

Many countries have malnutrition and a vast amount of food insecurities. It is extremely important to find nutrient dense, and cost effective food sources for people around the world. For centuries, legumes have been an important source of protein and calories for many people in the world. Lupin beans are primarily grown in Australia, Poland, and the Mediterranean regions. They were utilized to increase nitrogen content of soil. Lupin beans are legumes grown from a lupinus plant. They have high protein and vitamin content. They are a good source of manganese, copper, magnesium, phosphorus, potassium, and zinc. Furthermore, they offer folate and vitamin C. This nutrient dense legume, combined with the probiotic content of sourdough breads, has the potential to be very beneficial to health.

Lupin beans are considered a pea in the legume family. They are growing ever more popular around the world. In fact, an article from the Journal of Agriculture states: “Their high seed yield, good growing, and harvesting characteristics also make them suitable for cultivation in many areas of the world” (Digna Ballester, 1980). The origin of the legume is quite interesting, in fact, “Lupin seeds where provided by a Greek grower Lashithi Creete, Grecce (E. Marki, 2005). Knowing this information it is easy to see where the name originated from Greek pisum sativum L.

meaning pea seed and vicia faba L. meaning the broad bean. (E. Marki, 2005). Many of the countries have used this bean plant to fortify the soil. It was discovered that this plant is especially economically and agriculturally friendly. The reasoning behind this is explained in an article used for this project, "Lupin bean has a strong capability for nitrogen fixation and organic phosphorus release from soil" (Agniezka Sujak, 2005). The task Lupin bean growers face now is to produce an alkaloid-free lupin bean for greater palpability. This is important because lupin beans can fortify food products by adding many nutrient benefits, and thus, becoming a functional food. One study states; "Lupin seeds may also be a potential source of alimentary cellulose for the production of dietetic food, the high protein fraction (25-40%) could be used as a substance for enriching types of products (Agniezka Sujak, 2005).

2. Materials and Methods:

2.1 Formulation of Sourdough:

For the preparation of grains into flours a Vitamix blender was used to grind beans. They were then sifted through 60 mm sieve to achieve uniform particle size. Recipe was standardized for sourdough starter. Sourdough was fortified with lupin beans for higher protein, vitamin, and mineral content. The flour mixtures are as follows: 100% all-purpose flour as the control group. Lupin bean used in 50% ratio to all-purpose flour, and 25% lupin with 75% all purpose

3. Physiochemical Analysis:

3.1 Moisture Content:

An air oven method was used to determine the moisture content of a 5 g sample at 110*C for 3 hours. It will be expressed as a percentage of dry weight of the sample.

Moisture content (%) : $\frac{weight\ of\ dish+sample-(weight\ of\ dish+dried\ sample)}{weight\ of\ sample} * 100$

3.2 Rising power of dough:

% rise was measured by marked glass beakers and a meter stick with mm to see the variable differences.

3.3 pH:

pH was measured at room temperature (27*C). The pH meter was inserted directly into sourdough sample with a pH/ORP Meter (HiI9125, HANNA instruments Co. Ltd). pH meter was calibrated with a buffer standard of pH 4 and pH 7 prior to use.

3.4 Color study:

This was measured by conducting a hunter lab system to accurately measure true color of bread product. This was done utilizing the UV spectrometer to measure the samples outer color of bread. The data collected was put into a table using the A L B parameters. This test was conducted at Oklahoma State University's food science laboratory.

3.5 Texture Analysis:

Texture was measured by penetrometer (PNR 12 Penetrometer, from Anton Parr Technology). The bread samples were measured by placing samples under the cone. The measurement of bread firmness was captured by precision penetrometer where the compression force was determined by the function of the deformation. With the firmness test, the resistance force of the sample was relative to the penetration of the cone.

3.6 Nutritional Analysis:

This was measured by conducting nutrient analysis of sourdough by Genesis R&D Software (ESHA Research). The recipes for each bread sample were entered into program, and nutrients were calculated by software.

3.7 Sensory evaluation:

Sensory analysis (color, taste, texture, smell, crumb, overall acceptance) was evaluated with 50 panelist called from the University of Central Oklahoma. A 9-point hedonic scale ranging from extremely like (9) to dislike (0) was used. A palette cleanser (water) was provided between tasting samples. The sensory evaluation was conducted at the University of Central Oklahoma with volunteer students in the Human environmental science building, and fellow nutrition students. IRB approval for this study number is 17003.

3.8 Statistical Analysis:

All tests were conducted in triplicate. All statistical analyses including calculation of average, standard deviation, and graphs were carried out using Microsoft Excel.

4. Results and Discussion:

The results indicated that pH and moisture content of dough was increased with increase in lupin bean flour concentration (Figure 1). This is because the lupin flour absorbs more water. The rise of the dough decreased with amount of lupin bean present (Table 1). This is because there is less gluten formation, and thus, during the rise stages, the yeast is unable to feed on as much starch to leaven the bread as effectively.

Table 1. Results of moisture content, pH, and percent rise.

	% Moisture Content	pH	% Rise
100 % All Purpose Flour	2.70% ±0.17	3.86 ±0.06	64.24mm ±0.01
25% Lupin and 75% All Purpose Flour	2.90% ±0.01	5.39 ± 0.01	60.20mm ±0.05
50% Lupin and 50% All Purpose Flour	3.20% ±0.37	5.63 ±0.06	58.84mm ±0.37

On the color analysis, L represents the black to white spectrum, so the higher the number 1-100 signifies a lighter color (Table 2). The A represents the red to green colors on the spectrum of -60 (green) to +60 (red).. Thus, one can conclude that the bread samples were closer to a red color on the spectrum. Finally, the B represents blue (-60) to yellow (+60) on the spectrum, and clearly the bread with more lupin bean has a more yellow color.

Table 2: Results of Hunter Color lab.

	L	A	B
100% All Purpose Flour	72.41 ±1.85	6.84 ±0.08	21.36±0.46
25% lupin, 75% All Purpose Flour	74.01 ±2.89	7.34±0.63	20.96 ±0.99
50% lupin, 50% All Purpose Flour	72.61±1.58	10.94±0.72	33.56 ±0.99

The penetrometer reading results for texture showed that the softness of bread was increased during fortification by lupin bean flour. This is indicated by increase in distance travelled by penetrometer probe (Table 3). The softer texture might be attributed to the high water absorption capacity of lupin beans.

Table 3: Texture of bread (penetrometer reading in mm)

	Distance	**Min**	**Max**	**Std. dev.**
100% All Purpose Flour	6.96mm	5.32mm	7.84mm	±1.42
25% lupin, 75% All Purpose Flour	9.91mm	9.37mm	10.32mm	±0.49
50% lupin, 50% All Purpose Flour	11.89mm	10.83mm	13.31mm	±1.28

Nutritional analysis showed that protein, iron, calcium and Vitamin C concentration is increased in lupin bean fortified bread (Figure 1). This was obvious as lupin beans are rich in protein, iron, calcium and Vitamin C.

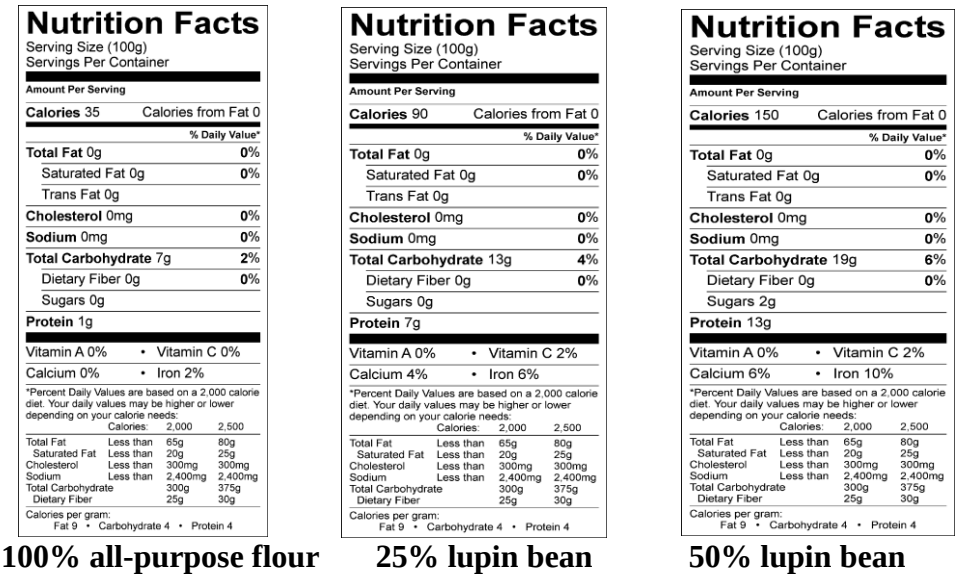

Figure 1: Nutritional Analysis.

Furthermore, sensory evaluation results indicated that consumers preferred the control samples compared to fortified samples (Figure 2). This was expected as lupin bean has characteristic taste and consumers may take time to adjust with this new taste. The data did provide a likability of appearance, and some did favor the texture of bread. It was an untrained panel, and there is possibility that trained panel would have created a better consensus about the bread.

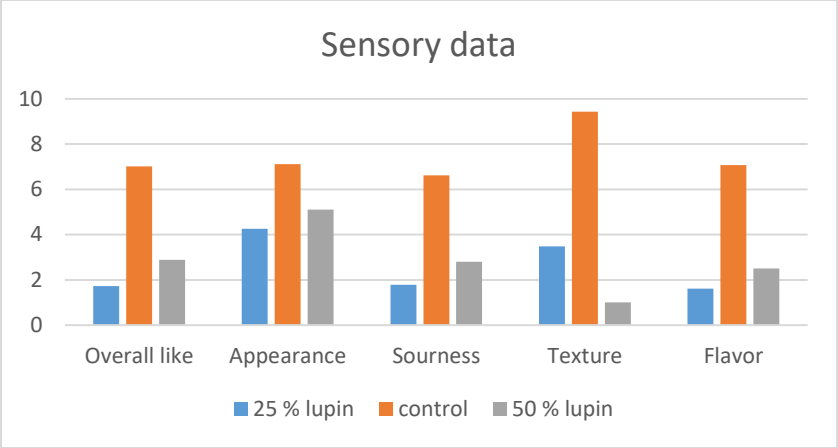

Figure 2: Sensory Evaluation Results

5. Conclusions:

Nutrient dense lupin fortified sour dough bread was created, optimized and characterized. The lupin bean fortified bread will potentially provide a nutrient dense alternative to traditional sourdough bread and offer many health benefits. It may help impoverished countries create a high yielding nutrient dense food source.

6. Acknowledgement:

- This project is based on work supported by a grant from the Office of High-Impact Practices, University of Central Oklahoma,
- We thank Chuck Bishop, Anton Parr Technology for help in penetrometer measurements.
- We thank Dr. Ranjith Ramanthan, Oklahoma State University for helping in color measurements

7. References

1. Agniezka Sujak, A. K. (2005). Compostional and nutritional evaluation of several lupin seeds. *Elsevier, Food Chemistry*, 710-719.
2. Alberto Rubio-Tapia, M. J. (2012). The Prevalence of Celiac Disease in the United States. *The American journal of Gastroenterolgy*, 1538-1543.
3. Anna-Sophie Hager, A. W. (2012, September 12). Nutritional properties and ultra-stucture of commercial gluteen free flours from different botanical sources compared to wheat flours. *Journal of Cereal Science*, 239-247.
4. Digna Ballester, E. Y. (1980, may 8). Chemical compostion and toxicologial Evelution of two species of sweet lupine. *Journal of agric Food Chem*, pp. 402-405.
5. E. Marki, E. P. (2005). Syudy of functional properties of seed strorage protiens from indigenous European legume crops (lupin, pea broad bean) in admixture with polysaccharides. *Elsevier*, 584-594.
6. Elena Yazynina, ,. M. (2008). Low folate content in gluten-free cereal products and thier main ingredients. *Food Chemistry*, 236-242.
7. M. Mercedes lucas, F. L.-V. (2015, september 1). The future of lupin as a protein crop in Europe. *Frontier in plant science*, pp. 1-6.
8. R. Belski, T. M. (2011, october 12). Effects of lupin-enriched foods on body compostion and cardio vascular disease risk factors: a 12:month randomized controlled weight loss trail. *International Journal of Obesity*, pp. 810-819.
9. Szczesniak, A. S. (1962, septemeber 5). objective measurment of food texture. *Technical Center, General Foods Corparation*, p. 1962.
10. Vickie A. Vaclavik, E. W. (2014). *Essentials of Food Science.* New York: Springer Science+Business Media.