2007-07-01

# Quality of hermetically packaged split peas during long-term storage

J. S. Chapman

Laura K. Jefferies
laura_jefferies@byu.edu

Oscar A. Pike
oscar_pike@byu.edu



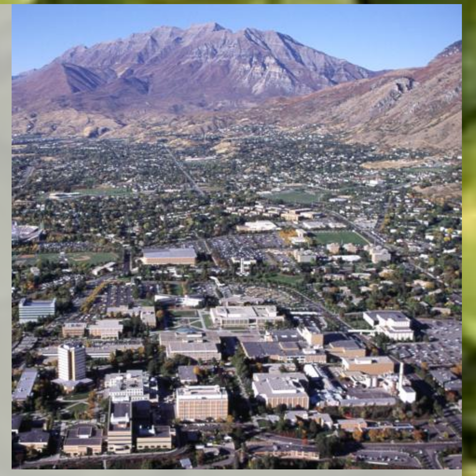
## Original Publication Citation

Chapman JS, Jefferies LK, Pike OA. July 27. Quality of hermetically packaged split peas during long-term storage. Poster presentation. Institute of Food Technologists Annual Meeting.

# Quality of Hermetically Packaged Split Peas During Long-term Storage

J.S. Chapman, L.K. Jefferies, O.A. Pike

Department of Nutrition, Dietetics and Food Science, Brigham Young University, Provo, UT 84602



## Abstract

There is a market for low moisture foods that can be stored for long periods of time for use in disaster relief and other emergency situations. Split peas hermetically sealed in cans having a reduced oxygen atmosphere are available in the retail market, but the effect of long-term storage on the quality of the product is unknown.

Nine samples of split peas representing 5 retail brands packaged in nr 10 cans and stored at room temperature were obtained from donors. Two fresh samples of split peas were purchased as controls. Samples ranged in age from <1 to 34 years. Can headspace oxygen, can seam integrity, and raw product water activity, color, and hardness were evaluated. Using a basic formulation consisting of split peas, salt, and water, split pea soup was prepared using each of the samples. A 52-member consumer panel evaluated the split pea soup for appearance, aroma, texture, flavor, and overall acceptability using a 9-point hedonic scale. Acceptance for use in everyday and emergency situations was also determined. Thiamin and riboflavin was measured for each sample.

Can headspace oxygen ranged from 0.19 to 20.1%. All can seams were determined to be satisfactory. Water activity of the raw split peas ranged from 0.41 to 0.56. The green color of the raw split peas decreased over time as shown by increasing CIE a* values. Hardness was found to significantly increase over time. Flavor, appearance, texture, and overall acceptability hedonic scores ranged from 6.7 to 4.4 and decreased over time. Hedonic scores for appearance were correlated with the decrease in raw product green color ($r2 = .928$). Hedonic scores for texture declined over time, corresponding with increasing hardness of the peas. All samples had an acceptance in an emergency situation of over 75%. Thiamin was significantly lower in older samples while riboflavin remained unchanged.

Results indicate split pea quality declines over time, but the product maintains sufficient sensory acceptance to be considered for use in applications requiring long-term storage.

## Introduction

The U.S. Department of Homeland Security encourages efforts by individuals to be prepared for natural disasters and other emergencies, including the storage of food (Anon. 2006a). The American Red Cross also counsels that food be kept in case of emergencies (Anon 2006b). Split peas packaged in nr 10 cans with a low oxygen atmosphere has been available in the retail market for decades, but the effect of long-term storage on quality is unknown. Though the "hard-to-cook" phenomenon in legumes is well known and has been extensively studied, very little data exist in the literature concerning such effects as hardening, sensory acceptance, and vitamin content over long-term storage of split peas. Therefore, the purpose of this study was to determine the sensory and nutritional quality of hermetically packaged split peas during long-term storage at ambient temperatures.

## Methodology

### Samples

Nine samples of dry split peas packaged in nr 10 cans were analyzed. Samples ranged in age from <1 to 34 years. Control samples (<1 year of age) were obtained from a commercial vendor. All other samples were obtained from donors as described by Lloyd and others (2004), and had been stored in residential locations at ambient temperatures (approximately 13-27°C.) Duplicates from the same lot were obtained for sample ages <1, 15, and 29 years.

### Headspace Oxygen, Can Seam, Water Activity, Color, and Texture

Headspace oxygen was measured using a 6500-Series Headspace Oxygen Analyzer (Illinois Instruments, Inc., Johnsburg, Ill.). Can seams were evaluated using the SeamMate System (Onevision Corporation, Westerville, Ohio) to measure the thickness, body hook, cover hook, width, and overlap. Seam tightness was rated on a scale of 0-100% by an experienced evaluator. Water activity was measured via the chilled mirror technique using an Aqualab CX-2 (Decagon Devices, Inc., Pullman, Wash.). Color was quantified on the CIE L*, a*, b* scale using a HunterLab ColorFlex spectrophotometer (Hunter Associates Laboratory, Inc., Reston, Va.). Using a method modified from Anzaldua-Morales and others (1996), an objective measure of texture of the cooked split peas was quantified using a TA-XT2 Texture Analyzer (Texture Technologies, Scarsdale, N.Y.) using a 2mm cylinder probe and defined as the hardness value, the force (in Newtons) required to penetrate the peas. Forty randomly selected peas were tested from each sample.

### Sensory Evaluation

A 52-member consumer taste panel was conducted on prepared split pea soup at the Brigham Young University Sensory Laboratory. The split pea soup was made by initially soaking 454 grams of dried split peas overnight at a ratio of 3:1 water:peas (Charley and Weaver, 1998). The soaked split peas and 7.5g of salt were added to 2130 mL water then cooked at a constant boil for 1 hr 20 minutes; the pan was uncovered for the last 25 minutes of cooking. After cooking, the soup was blended using a GE Hand Blender (Model 106757, Fairfield CT) to a uniform consistency. The soup samples were then held on a steam table at 170°C and served to the panelists in a randomized order during 4 visits. Six samples (in sets of three) were presented each visit and every sample was evaluated twice by each panelist.
Panelists evaluated the prepared split pea soup for aroma, flavor, texture, appearance, and overall acceptability using a 9-point hedonic scale where 1=dislike extremely and 9=like extremely. Acceptance was determined by asking panelists if they would eat the sample as part of their regular diet and if they would eat it in an emergency situation.

### Thiamin and Riboflavin

Thiamin and riboflavin in raw split peas were determined using the method of Arella and others (1996) with modifications. The split pea samples were first ground using a coffee grinder (model E160B Proctor Silex, Southern Pines, NC) and further ground using a cyclone sample mill (UDY Corp., Fort Collins, CO). Five g of sample were accurately weighed into a 250 mL autoclavable bottle. Fifty mL of 0.1 M hydrochloric acid was added and stirred with a wooden dowel. The bottle was placed in a boiling water bath for 30 min. To prevent clumping, the samples were stirred with a wooden dowel every 10 min. After cooling, the solution was adjusted to pH 4.5 with 2.5 M sodium acetate. Then 500 mg of takadiastase (Fluka, St. Louis, MO) was then added during swirling to prevent clumping. The solution was incubated for 18 h at 37°C then filtered (Whatman # 41) and diluted to 250 mL.
The filtrate was filtered through a cellulose acetate filter (0.2μm) into an amber sample vial and analyzed for riboflavin using HPLC. One mL of the first filtrate was added to a test tube containing 3 mL alkaline potassium ferricyanide (1 mL of 1% (v/v) potassium ferricyanide and 24 mL of 3.75M sodium hydroxide). The solution was shaken by hand, left to stand for 1 min, then 1 mL was removed and diluted to 25 ml using 0.6 M acetic acid solution. The final solution was filtered through a cellulose acetate filter (0.2μm) into an amber sample vial and analyzed using HPLC for thiamin (as thiochrome). The fluorometric detector was operated at an excitation wavelength of 366 nm and at an emission wavelength of 435 nm for thiochrome and at an excitation wavelength of 422 nm and at an emission wavelength of 522 nm for riboflavin, as recommended by Arella and others (1996).

### Data Analysis

Data was analyzed for significance at α = 0.05 using Statistical Analysis System software (SAS Institute, Cary, NC). Analysis of variance (PROC GLM) was used to analyze color and nutrition data. Sensory data was analyzed using a mixed model repeated measures analysis of variance (PROC MIXED). Both models used the Tukey-Kramer procedure to determine significant difference among means. Correlations were calculated using Microsoft Excel software.

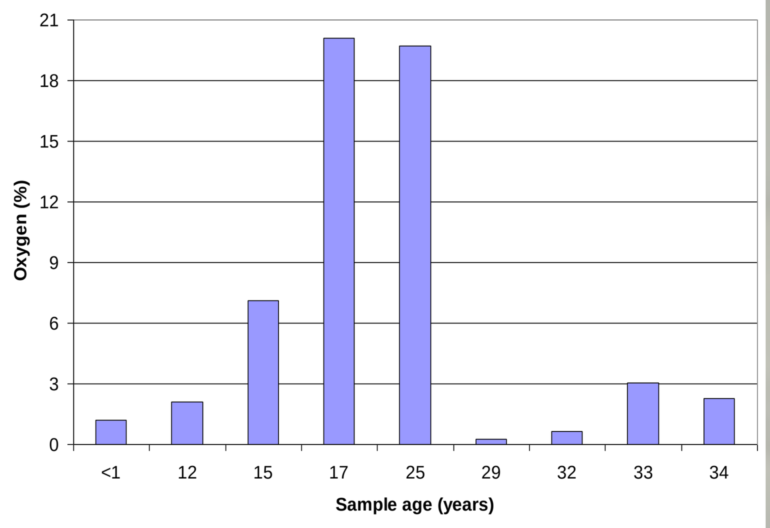



Figure 1 – Percent oxygen in can headspace of split pea samples stored up to 34 years.

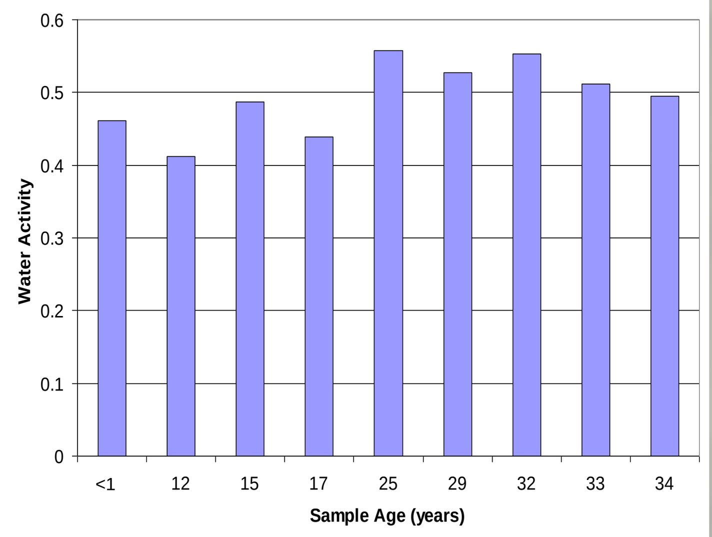



Figure 2 - Water activity of split pea samples stored up to 34 years.

**Table 1 - Hunter L*,a*,b* values for split pea samples of varying age**

| Age (years) | L* | a* | b* |
|---|---|---|---|
| <1 | 45.9 | -6.42 | 24.8 |
| 12 | 49.9 | -3.97 | 25.8 |
| 15 | 47.5 | -3.17 | 25.9 |
| 17 | 45.4 | -3.82 | 25 |
| 25 | 51.4 | 1.69 | 22.3 |
| 29 | 50.3 | 2.45 | 27.6 |
| 32 | 50.3 | 2.85 | 28.2 |
| 33 | 55.9 | 2.37 | 29.6 |
| 34 | 50.3 | 2.29 | 28.3 |

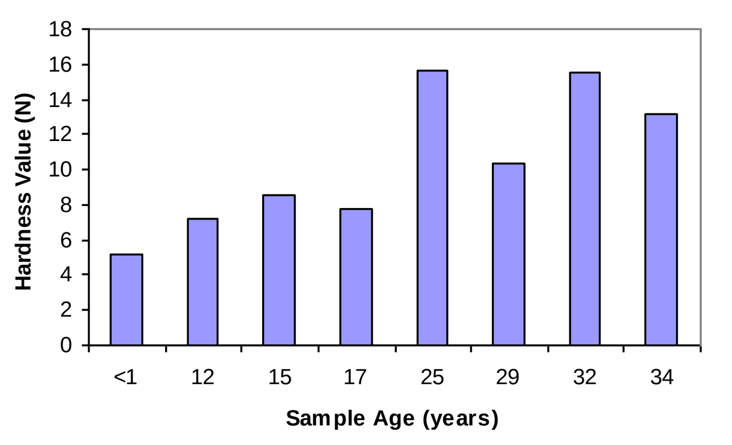



Figure 3 - Hardness value of split pea samples stored up to 34 years. Value represents the force (in Newtons) required to penetrate a single pea (n=40) with a 2 mm probe.

**Table 2. Mean hedonic scores of split pea soup. Common superscripts in the same column indicate no significant difference. p>0.05 (n=104)**

| Age in Years of Sample | Overall Acceptability | Aroma | Flavor | Texture | Appearance |
|---|---|---|---|---|---|
| <1 | $6.7^{a}$ | $6.4^{a}$ | $6.8^{a}$ | $6.5^{a}$ | $6.3^{a}$ |
| 12 | $6.0^{ab}$ | $6.2^{abc}$ | $6.2^{ab}$ | $5.8^{ab}$ | $6.1^{ab}$ |
| 15 | $5.6^{bc}$ | $6.3^{abc}$ | $5.8^{bc}$ | $5.6^{bc}$ | $5.8^{abc}$ |
| 17 | $5.2^{bcd}$ | $5.9^{abcde}$ | $5.6^{bcd}$ | $5.0^{bcd}$ | $5.5^{bcd}$ |
| 25 | $3.9^{g}$ | $4.9^{h}$ | $4.1^{g}$ | $3.7^{g}$ | $4.2^{g}$ |
| 29 | $4.7^{def}$ | $5.7^{cdef}$ | $5.1^{def}$ | $4.3^{def}$ | $5.3^{cdef}$ |
| 32 | $4.1^{fg}$ | $5.6^{cdefgh}$ | $4.7^{defg}$ | $3.7^{fg}$ | $4.5^{g}$ |
| 33 | $4.9^{de}$ | $6.0^{abcde}$ | $5.2^{cde}$ | $4.6^{def}$ | $5.5^{cde}$ |
| 34 | $4.4^{defg}$ | $5.7^{bcdefg}$ | $4.9^{defg}$ | $4.0^{efg}$ | $4.6^{efg}$ |

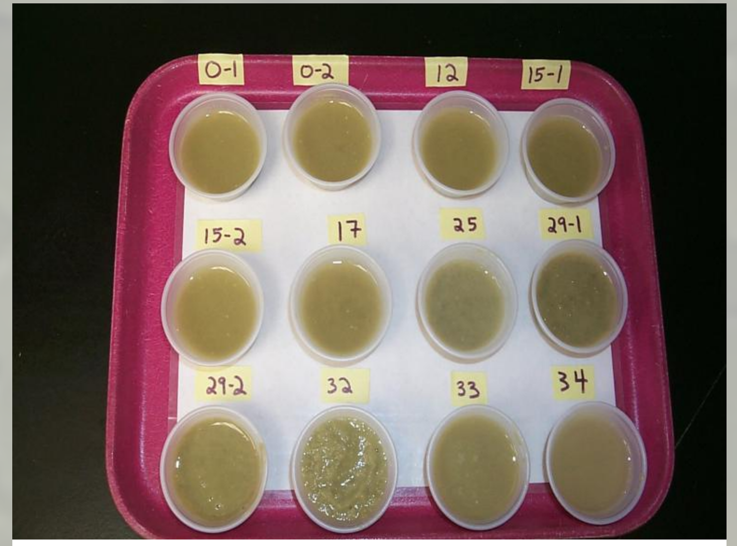



Figure 4 - Visual appearance of split pea soup prepared for sensory evaluation. Hyphenated numbers represent sample age (in years) and duplicate samples from the same lot.

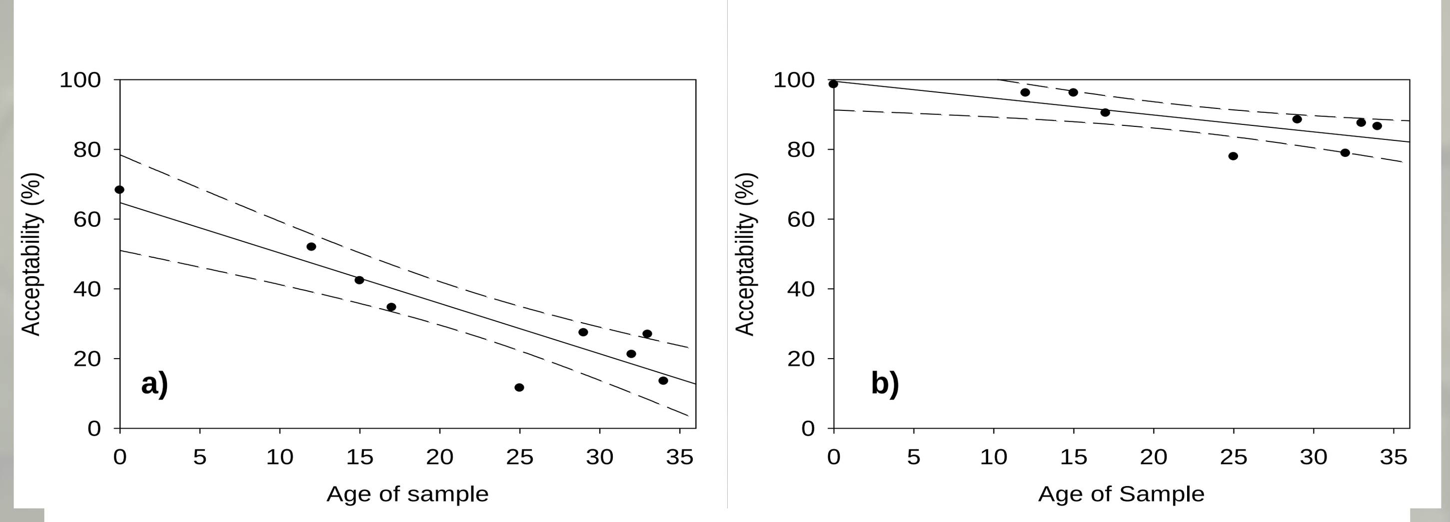



Figure 5 - Percentage of panelists who would eat split pea soup prepared from split peas samples stored up to 34 years. (a) Acceptability for regular use. (b) Acceptability for use in an emergency situation. Dashed line represents the 95% confidence interval, (n=104)

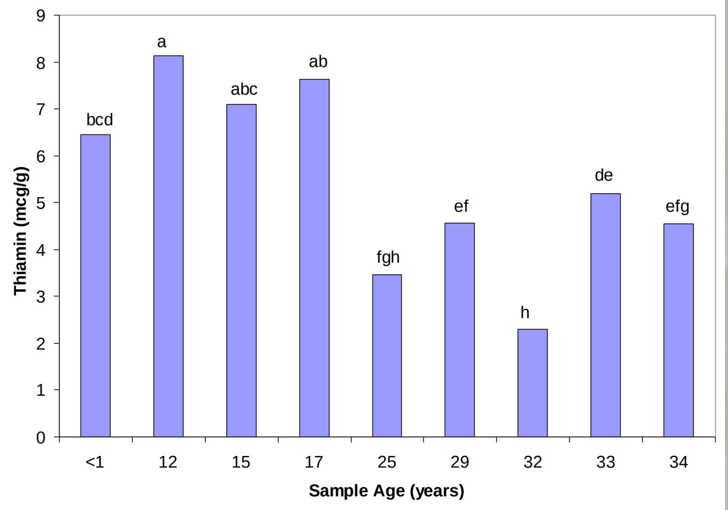



Figure 6 - Thiamin content of split pea samples stored up to 34 years.

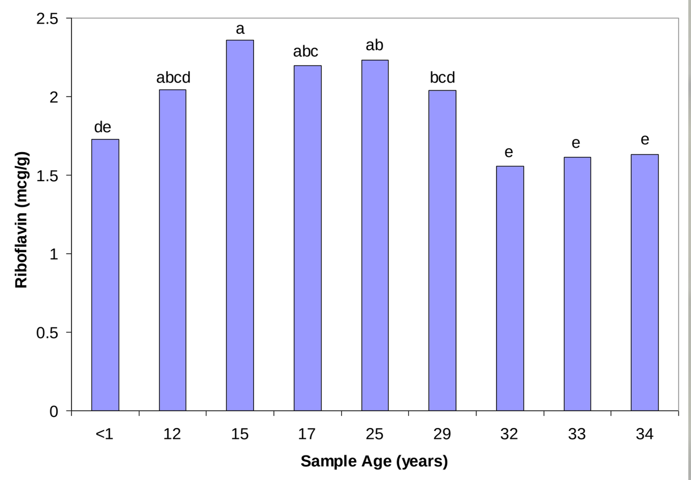



Figure 7 - Riboflavin content of split pea samples stored up to 34 years.

## Results and Discussion

### Headspace Oxygen, Can Seams, Water Activity, Color, and Texture

Headspace oxygen levels in the cans showed wide variation, ranging from 0.19 to 20.1% (Figure 1). Samples 17 and 25 had atmospheric levels of oxygen, suggesting an ineffective oxygen removal treatment. Only one third of the samples had < 2% headspace oxygen. All can seams were found to be satisfactory (data not shown). Water activity ranged from 0.41 to 0.56 (Figure 2). CIE L* values ranged from 45.4 to 55.9 (Table 1). CIE a* values ranged from -6.4 to 2.9. CIE b* values ranged from 22.3 to 29.6. The a* values significantly increased as the sample ages increased, suggesting the split peas decreased in green color during storage. L* and b* values did not change significantly as sample age increased.

Figure 3 shows the hardness values of each sample. Hardness values ranged from 5.21 to 15.66 N. The hardness values significantly increased as sample age increased.

### Sensory Evaluation

Hedonic score means for the split pea soup ranged from: 4.2 to 6.3 for appearance, 3.7 to 6.5 for texture, 4.1 to 6.8 for flavor, 4.9 to 6.4 for aroma, and 3.9 to 6.7 for overall acceptability (Table 2). There was significant decrease as sample age increased in hedonic scores for aroma, flavor, texture, appearance, and overall acceptability, with the smallest change occurring in the aroma of the samples and the largest change occurring in the texture of the samples. Split pea appearance hedonic scores correlated with CIE a* values ($r^2$=0.66). Texture hedonic scores were correlated ($r^2$=0.87) with hardness values obtained from the texture analyzer. Overall hedonic scores also were correlated ($r^2$=0.90) with hardness values. Figure 4 is a photograph of prepared split pea soup samples that were served to panelists and shows differences in soup thickness and color.

Everyday acceptance ranged from 11 to 68% but emergency acceptance for all samples remained above 75% (Figure 5).

### Thiamin and Riboflavin

Thiamin values ranged from 3.5 to 8.1 μg/g of sample (Figure 6). The USDA database value of 6 μg/g is higher than most of the samples. There was a significant decrease of thiamin values over time. However, a correlation ($r^2$=0.88) was found between thiamin levels and water activity, which suggests that the decrease in thiamin levels may have had more to do with too high of water activity than storage time.

Riboflavin values ranged from 1.6 to 2.4 μg/g of sample (Figure 7). The USDA database lists a value of 2.2 μg/g of sample, meaning that most of the samples were below the listed value. There was not a significant decrease in riboflavin content with increasing sample age.

## Conclusions

There was a loss of some quality attributes of the split pea samples as sample age increased such as thiamin levels, sensory scores, and texture. Thiamin was lower in samples older than 17 years, but riboflavin was not significantly different. Emergency acceptance remained above 75% for all samples. Sensory scores appeared to reflect the hardness of the peas which, as measured objectively, increased with sample age. Inasmuch as the seed coat of split peas is ruptured, there may be other factors in the hard-to-cook phenomenon besides the water penetration through the seed coat or the hilum of legumes. Split peas can become an important part of a long-term storage plan because of its their general stability when properly packaged and stored.

## Acknowledgements

The authors appreciate the funding for this research provided by Ira Fulton and the contributions of the following individuals: Raymond Lambert, Heather Pahulu, Stephanie Bartholomew, and Jiping Zou.

## References

Anon. 2006a. U.S. Department of Homeland Security. Make a Kit: Food and Water. Available from http://www.ready.gov/america/_downloads/trifold_brochure.pdf. Accessed on June 14, 2007.

Anon. 2006b. American Red Cross. Food and Water in an Emergency. Available from http://www.redcross.org/static/file_cont39_lang0_24.pdf. Accessed on June 14, 2007.

Anzaldua-Morales A, Quintero A, Balandran R. 1996. Kinetics of Thermal Softening of Six Legumes During Cooking. J Food Sci 61(1):167-170.

Arella F, Lahely S, Bourguignon JB, Hasselmann C. 1996. Liquid chromatographic determination of vitamins B1 and B2 in foods. A collaborative study. Food Chem 56(1):81-86.

Charley H, Weaver C. 1998. Foods, a Scientific Approach. Upper Saddle River, New Jersey: Prentic-Hall, Inc. 582 p.

Lloyd MA, Zou J, Ogden LV, Pike OA. 2004. Sensory and nutritional quality of nonfat dry milk in long-term residential storage. J Food Sci 69(8):S326-S331.