Quality of hermetically packaged split peas during long-term storage

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Abstract
There is a market for low moisture snacks that can be stored for long periods of time for use in disaster relief and other emergency situations. Split pea soup has been used in cases having a natural disaster, an emergency, or war so that a stable, non-perishable product is available in the retail market, but the effect of long-term storage on the quality of the product is unknown. Nine samples of split pea soup were stored at 10°C and sampled at room temperature from donors. Two fresh samples of split pea soup were purchased as controls. Samples ranged in age from 1 to 34 years. Control samples were dehydrated in a vacuum oven and stored at room temperature from the same source for a fresh sample and for 35°C sterilized sample. Color was measured using the CIE *L*, *a*, *b* system. Sensory evaluation was performed by 50-member consumer preference test panels. Sensory analysis of the samples. An A5-member consumer panel evaluated the split pea soup for appearance, aroma, texture, flavor, and overall acceptability. For acceptance in use as an emergency food, liking had to be determined. Thiamin and riboflavin were measured for each sample.

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. 2006). The American Red Cross also cautions that food be kept at safe temperatures (Anon. 2006). Split pea soups, in particular, have been suggested as a potential food for long-term storage because of its high thiamin content. Thiamin is a b-water-soluble vitamin which is not appreciably destroyed by normal cooking, canning, and freezing. Thiamin deficiency can be harmful to the body, and the American Medical Association (AMA) suggests that preliminary cooking should be done before storage to increase the thiamin content of the food. However, the data were not conclusive in determining the effectiveness of cooking on the thiamin content of split peas stored during long-term storage at ambient temperature.

Methodology
Samples
Nine samples of dry split peas was packaged in 10 re-useable cans. Samples ranged in age from 1 to 34 years. Control samples were dehydrated in a vacuum oven and stored at room temperature from the same source for a fresh sample and for 35°C sterilized sample. Headspace Oxygen, Can Seam, Water Activity, Color, and Texture
Headspace oxygen was measured using a 4500-Series Headspace analyzer (Bomex Instruments, Inc., Johnson City, TN). Can seams were examined using the Sealed Applications System (Cincinnati, OH). Water activity was measured using a Decagon Devices’ (Pullman, WA) psychrometer. Color was quantified on the CIE *L*, *a*, *b* scale using a Hunterlab ColorFlex spectrophotometer (Reston, VA). Texture was measured using a SeamMate 2 Texture Analyzer (Tecmark Inc., Tempe, AZ) using a 3-mm probe and defined as the hardness value, force (in Newtons) required to penetrate the sample. The appearance of the samples was first examined by the sensory and nutritional quality of hermetically packaged split peas during long-term storage at ambient temperature.

Sensory Evaluation
A 50-member consumer taste panel was conducted on prepared split pea soup at the Brigham Young University Sensory Sciences Laboratory. The sample soup was made by boiling 30 g of dried split peas overnight in 31.3 water (Cheyney and Worsley, 1998). The cooled split pea soup was added to 780 ml of water, then cooked at a constant boil for 1 to 2 min; the soup was cooled for 25 min. After cooling, the soup was blended using a GHD Hand Blender (Model 10757B). Farinograph C1) is a uniform consistency. The samples were then blended in a flour table at 17°C and served to the panellists in a randomized order during 4 min. Each sample was served in a原则 each sample and was evaluated twice by each panellist. Panelists evaluated the prepared split pea soup for acceptability, flavor, texture, appearance, and overall degree of liking. The Can Seam term was determined by looking at the seal and the spot at the regular drip and if it was held it was a good emergency situation.

Thiamin and Riboflavin
Thiamin and riboflavin in raw split peas were determined using the method of Aneto and others (1994) with modifications. The split pea samples were ground using a coffee grinder (model 81386 Proctor Silex, Southern Homesteading, Inc., Ilion, NY) and further ground using a Wiley mill (Wiley Corp., Canton, MA). A 5-g sample of the ground peas was extracted with a mixture of methanol and water (1:1) containing 50% (v/v) of a 0.1 M hydrogen chloride solution, and then filtered through a calcium acetate filter (0.25 μm) into an amber sample vial and analyzed using HPLC for thiamin by chromatography on a reverse-phase C18 column (150 mm x 2.1 mm, 5 μm). The mobile phase was a mixture of 0.1 M sodium acetate (pH 4.0) and acetonitrile (40:60, v/v) filtered through a cellulose acetate filter (0.22 μm) and then filtered using a sample vial for analysis.

Data Analysis
Data was analyzed for significance at a 0.05 level using the Statistical Analysis System (SAS Institute, Cary, NC). Analysis of variance (PROC GLM) was used to analyze color and nutritional data. Sensory data was analyzed using a repeated measures analysis of variance (ANOVA) using SAS PROC GLM. The model was used to determine significant difference among means. Contrasts were calculated using Microsoft Excel software.

Results and Discussion
Headspace Oxygen, Can Seams, Water Activity, Color, and Texture
Headspace oxygen values in the range of 0 to 10% were determined in all the samples (Figure 1). Samples 17 and 25 had atmospheric levels of oxygen, suggesting an ineffective oxygen removal treatment. Only one third of the samples had a level of less than 3%. Oxygen activity was determined using a 41.2% to 0.6% (Table 2). CIE *L* values ranged from 4 to 8 to 4. The CIE *b* values significantly increased as samples increased in age (Table 2). CIE *a* values were decreased in green color during storage. *L* and *b* values did not change significantly as sample age increased (Figure 2).

Sensory Evaluation
Thiamin and Riboflavin
Thiamin values ranged from 2.5 to 8.8 g per sample. Thiamin activity was measured using a method involving 4-hr, 4°C, 10% sodium chloride solution and was overall acceptable with the smallest decrease in thiamin activity in 17 years. Riboflavin content was determined by measuring the value of the quantity of thiamin in the sample. The USDA database has a value of 2.2 g of riboflavin. The results of the study were below the list value. There was not a significant decrease in riboflavin content with increasing sample age.

Conclusions
There was a lack of some quality attributes of the products. It is suggested that the sample age increased such as thiamin levels, sensory scores, and texture. Thiamin was lower in sample older than 17, but riboflavin was not significantly different. It is suggested that the samples be refrigerated and canned before storage. Riboflavin values ranged from 1.6 to 2.4 g per sample (Figure 7). The USDA database has a value of 2.2 g of riboflavin. The results of the study were below the list value. There was not a significant decrease in riboflavin content with increasing sample age.

References
Acknowledgements
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Figure 1 – Percent changes in cap headspace of split peas samples stored up to 34 years.

Figure 2 – Water activity of split pea samples and controls.

Figure 3 – Hardness values of split pea samples (stored up to 34 years).

Figure 4 – Visual appearance of split pea soup.

Figure 5 – Percentage of panelists who would eat split pea soup prepared from split pea samples stored up to 24 years. (a) Agreement for regular use, (b) Acceptability for use in an emergency situation. Dashed line represents the 65% confidence interval, (in bold).

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.

Table 1 – Percentage of panelists who would eat split pea soup prepared from split pea samples stored up to 24 years. (a) Agreement for regular use, (b) Acceptability for use in an emergency situation. Dashed line represents the 65% confidence interval, (in bold).

Table 2 – Mean sensory scores of split pea soup. Contrast is significant to the same standard. (p<0.01).