MODIFIED ATMOSPHERE PACKAGING OF GREEN-SHELLED COMMON BEANS

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Many consumers in Puerto Rico prefer to eat green-shelled common beans (*Phaseolus vulgaris* L.) compared to canned, dried or frozen beans. Like fresh vegetables and fruits, green-shelled beans remain metabolically active postharvest. As a consequence, green-shelled beans have a short postharvest shelf-life of no longer than a few days. Modified atmosphere packaging (MAP) is a packaging system that uses a semi-permeable packaging material, composed of a gas atmosphere other than air, that slows the basic level of metabolism. For the last decade, MAP has been used to extend the shelf-life of respiring products. The shelf-life of green-shelled beans could be extended with MAP in conjunction with the appropriate storage temperature, thereby delaying physiological deterioration. MAP depends on 2 variables, the respiration rate of the product that is packed and the permeability of the packaging material (Church and Parsons, 1995). Therefore, the objective of this research was to experimentally determine the respiration rate of beans and to develop a modified atmosphere packaging system for green-shelled common beans, in order to increase shelf-life with minimal physiological changes.

Green-shelled seeds of the white bean cultivar ‘Morales’ were used for this research (Beaver and Miklas, 1999). The beans were harvested at the Isabela Substation of the University of Puerto Rico, Agricultural Experimental Station, and transported to a laboratory at 4 °C. The bean pods were shelled mechanically using a ‘Little Sheller’ manufactured by Taylor Manufacturing Co, Moultrie, GA. Green-shelled beans with no visible damage were used for the study. In the respiration rate study, the experimental unit was 250 g of green-shelled beans placed in a 950 ml glass jar. The jars were placed in controlled temperature environments of 5, 10, 15 and 24 °C. The four treatments were replicated three times. Everyday the jars were sealed for 4 hours. The respiration rate, percentage of CO₂, was measured each day 4 hours after the jars had been sealed. This procedure was performed on the same jars. Daily respiration rates were measured until physiological changes or microbiological deterioration began to appear. Gas samples were extracted from the jars using a 10 ml syringe and analyzed in a gas analyzer (Servomex Food Package Analyzer Series 1400, Norwood, MA). The respiration rate was calculated as ml CO₂/kg*hr on a fresh weight basis, using the following equation: CO₂ = Head space volume (ml) * Change in CO₂ % in the jar. Final rate of CO₂ (R₂O₂) is expressed in mg CO₂/kg*hr. In the second study describing a MAP system, the green-shelled beans were harvested, handled and sorted, as described in the respiration study. Color, pH, titratable acidity, texture and water activity analyses were performed on the green-shelled beans before packaging them under different modified atmospheres. The experimental unit was 225 g of green-shelled beans packed in Cryovac PD-961EZ plastic bags. The four gas combinations used to pack the beans were: 1) 4% O₂, 10% CO₂, and 86% N₂ (MAP-I), 2) 2% O₂, 5% CO₂, and 93% N₂ (MAP-II) and 3) 21% O₂, 0.03% CO₂, and 78% N₂ control (AIR). All of the packages were stored at 5 °C for 26.5 days. In addition to the above mentioned quality evaluations, changes in CO₂ within the packages were analyzed from 3 replicates of each gas treatment at 4-day intervals. On each day of analysis, 6 packages were taken out of the 5 °C storage. Gas and quality analyses were performed on 3 replicates, while the other 3 replicates were stored at 20 °C for 2 days, for
temperature abuse simulation. The gas and quality analyses on the 3 replicates of temperature abused packages were performed after 2 days.

The mean respiration rates of green-shelled beans were 15.94, 48.88, 73.95, 123.92 mg CO₂/kg*hr at 5, 10, 15 and 24 °C, respectively (Fig. 1). The green-shelled common beans stored in AIR maintained their overall quality at 5 °C for 10 days (p<0.05), while beans in MAP-I were able to maintain a fresh-like quality up to 18 days at 5 °C (p< 0.05). During their shelf-life, beans in both the AIR and MAP-I treatments maintained their color, texture, titratable acidity, pH and they remained free of off-odors, similar to freshly harvested green-shelled beans. The tenderness of the beans increased in both treatments, without any stickiness or off-odor, which could be beneficial in terms of reduced cooking time. Temperature abuse of any treatment, whether AIR or the gas mixtures of 4% O₂, 10% CO₂ and 86% N₂ (MAP I) and 2% O₂, 5% CO₂, and 93% N₂ (MAP II) was unfavorable, as it shifted the fermented off-odors within the packages to rotten odors and produced a softer texture that was sticky to the touch. Microbiological analysis along with the determination of ethanol and acetaldehyde, should be performed in order to determine if microorganisms contributed to the observed fermented and rotten off-odors. Additional sensory analyses would provide a more precise estimate of the actual shelf-life of the green-shelled common beans.

![Figure 1](image_url)

Figure 1. Respiration rate of green-shelled common beans in the form of mg CO₂/kg*hr at four different temperatures (5, 10, 15 and 24 °C). The vertical line signifies the end of shelf-life as determined by undesirable physiological changes or microbiological deterioration.

References


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