

INFLUENCE OF STORAGE TEMPERATURES ON THE POST-HARVEST QUALITY OF SNAP BEAN (*PHASEOLUS VULGARIS*L.)

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Abstract

A preliminary study was conducted where mature snap beans of *Samantha* variety, were collected from small holder farmers in 2 growing seasons and data was collected with a view to developing a model for short term storage for prediction of the relationship between storage conditions, physical and nutritional quality under low density polythene bags. Half of the samples were packed separately in open polythene bags while the other half was packed in closed polythene bags and stored at 5°C, 10°C, 15°C and 25°C and observations made for 9 days. It was observed that the higher the temperature, the higher the weight loss although the loss was higher in open polythene bags in all the storage temperatures. Similar trends were also observed in the loss of chlorophyll in both samples with samples stored at 25°C showing 5.5mg/L of chlorophyll content at day 9. There was a higher loss in total soluble solids in the samples stored in open polythene bags at 25°C with the samples showing 5.3% by day 9. There was a slower loss of vitamin C in samples stored in closed bags; however, the samples stored at 25°C for both treatments had the greatest loss by day 9. The results show that packaging in polythene bags has to be coupled with low temperature storage in order to receive a desirable shelf life.

Key words: Snap beans, storage temperatures, polythene bags, postharvest quality

1.0 Introduction

Snap bean (*Phaseolus vulgaris* L.) production has become increasingly important to the horticulture farming community and to the Kenyan community in general. It comes second to cut flowers in foreign exchange earners. In the year 2000, 26,672 tons of snap beans valued at KES 3.4 billion were exported mainly to the EU market and by 2004 snap bean export volume increased to 32,700 tons earning KES 5.5 billion (HCDA, 2000; 2004). Production is mainly by small to medium scale farmers and the enterprise creates on-farm employment opportunities for the rural community, especially youth and women. Snap beans are nutritionally rich in vitamin A, vitamin C, iron and calcium which can contribute significantly to mixed diets (Kelly and Scott, 1992).

Snap beans are categorized as a highly perishable vegetable and quickly deteriorate if not given proper temperature management. Quality of snap beans is related to cultivars and postharvest handling (Monda *et al.*, 2005). Recent data has shown that consumption of fresh and frozen beans has been on the increase compared to canned beans. The call for proper handling and management from harvest at rural farms to export exists (Monda *et al.*, 2003). The main importing countries are the UK, France and Germany among others.

In Kenya, there is a constant influx of new varieties through seed companies and produce exporters (Ndegwa, 2001; Ndungu, *et al.*, 2004). The local and export market for snap beans is dynamic and this has led to introduction of new varieties to meet market demands. The introduction of new snap bean varieties requires evaluation of their post-harvest characteristics in order to ascertain optimum handling procedures. Snap bean varieties, R-1515, R-1516, R-1262, *Samantha*, *Julia*, *Amy*, *Lexus* and *Paulista* and the locally improved variety *Kutulless* (J12) were evaluated for growth parameters, yield components and yields (kg/ha) at KARI, Thika during long and short rains season in the year 2001. That study made recommendations for National performance trials for the varieties that were found to be distinctly superior to the existing commercial varieties (Ndegwa *et al.*, 2001).

Snap bean (*Phaseolus vulgaris* L.) *Samantha* variety has been commercialized and has been grown in Kirinyaga District by the small holder farmers (Ndungu, *et al.*, 2004). It is a variety that is meant for fresh and frozen market although farmers also grow other varieties, e.g., variety *Julia* meant for canning. Small holder farmers have been practicing different handling techniques with a view to prolonging the shelf-life of the snap beans with little regard to the inherent quality characteristics. Low-density polythene bag packaging is being practiced at the farm level and therefore this research work was aimed at evaluating the post-harvest quality changes of Snap bean (*Phaseolus vulgaris* L.) variety *samantha* as influenced by temperature and low-density polythene bags packaging.

2.0 Materials and Methods

Mature fresh snap beans, *samantha* variety, were harvested from small holder farmers in two growing seasons, long rains season 2009 and short rains season 2009 in Kirinyaga District. At green pod maturity, the crop was harvested 3 times per week at one day intervals for 6 weeks. The pods were graded into the three standard categories defined by width of pod cross section (CS): extra fine (6 mm), fine (6-8mm) and Bobby (>8 mm) (KARI, 2005). The extra fine and fine categories comprised the marketable proportion of the harvest. Ten-pod samples of extra fine grade pods were selected randomly for assessment.

2.1 Chlorophyll Content

The content of chlorophyll was determined according to the method described by AOAC (1996). Four grams of the snap beans was weighed and ground in 16 ml of 100 % cold acetone; the homogenate was filtered and the residue rewashed with 80 % cold acetone until all the homogenate was colourless. The extract was made up to 40 ml with 80 % cold acetone. Using 80 % cold acetone as the blank, an aliquot of the extract was taken and the absorbance measured at both 663 nm and 645 nm using a spectrophotometer (Model UV mini 1240, Kyoto, Shimadzu, Japan). Chlorophyll content was calculated using MacKinney's coefficients (Equation 1) after measuring absorbance (A) at 645 and 663 nm:

$$\text{Total chlorophyll content } (\mu\text{g/g}) = 20.2A_{645} + 8.02A_{663} \dots\dots\dots(1)$$

2.2 Vitamin C (Ascorbic Acid) Content

The content of vitamin C was measured by visual titration using 2,6-dichlorophenol indophenol according to AOAC methods (1996). Five grams of the sample were weighed and ground in mortar and pestle with acid washed sand and some 10 % TCA solution. The ground sample was transferred quantitatively into a 100 ml volumetric flask, rinsed, made to the mark with 10 % TCA solution, mixed well and filtered. Ten (10) ml of the filtrate was titrated with indophenol solution until a pink colour appeared. For a blank, 10 ml of the 10 % TCA solution was pipetted in to a conical flask and distilled water equivalent to the volume of indophenol solution used in the titration was added. The mixture was titrated with indophenol solution until a pink colour appeared.

2.3 Total Soluble Solids

The total soluble solids was determined using an Atago hand refractometer (type 500, Atago, Tokyo, Japan). The results were expressed as degrees brix (°B).

2.4 Respiration Rates

The snap beans of a known weight were placed in jars of known volume whose covers were fitted with a self sealing rubber septum for gas sampling and incubated room temperature for one hour. One (1) ml of headspace gas was withdrawn using airtight syringe and injected into the gas chromatograph (GC) (model GC-8A, Shimadzu Corp., Kyoto, Japan). Carbon dioxide was determined using thermal conductivity detector with a Porapak Q column. Rate of carbon dioxide production were calculated as mg CO₂/ Kg/ hr at standard atmospheric pressure.

2.5 Weight Loss Determination

Samples of snap beans was packaged in both open and closed polythene bags at the start of the experiment and their initial weights noted. After each sampling interval, the weights were taken and the weight loss calculated as in equation 2:

$$\text{Weight loss} = \frac{(\text{Initial weight} - \text{Final weight})}{\text{Initial weight}} * 100 \% \dots\dots\dots(2)$$

2.6 Statistical Analysis

The statistical analyses of the results were mainly carried out by use of linear regression. Where applicable, data were subjected to analysis of variance (ANOVA) using statistical application software (SAS) and means separated by the Student-Newman-Keuls (SNK) test.

3.0 Results and Discussion

3.1 Respiration Rate

The results of the respiration rates are shown in Figure 1. The rate of respiration generally increased with increase in storage period with the respiration rates being significantly higher ($p \leq 0.05$) after twelve days of storage. The respiration rates were also significantly higher ($p \leq 0.05$) in the open polythene bags as compared to the closed bags at all the sampling intervals. It was also noted that the respiration rate shot up on the ninth day but remained insignificantly different ($p \leq 0.05$) after the third and sixth days. This indicates a major shift at the ninth day which indicates that it would be more prudent to store the snap beans for slightly less than nine days. This is in agreement with the studies carried out in USA which have indicated that the optimum storage period for the snap beans is 8 days.

The rate of respiration was also clearly affected by temperature, at each of the sampling periods, the rate of respiration was found to be significantly higher ($p \leq 0.05$) as the temperature was increased from 5°C to 25°C. It was also noted that the least increase in respiration rate was at 5°C. At 10°C, the rate of respiration was also low though significantly higher than at 5°C. It thus indicates that the best storage temperature would be 5°C and up to a maximum of 10°C. This is in agreement with the American study.

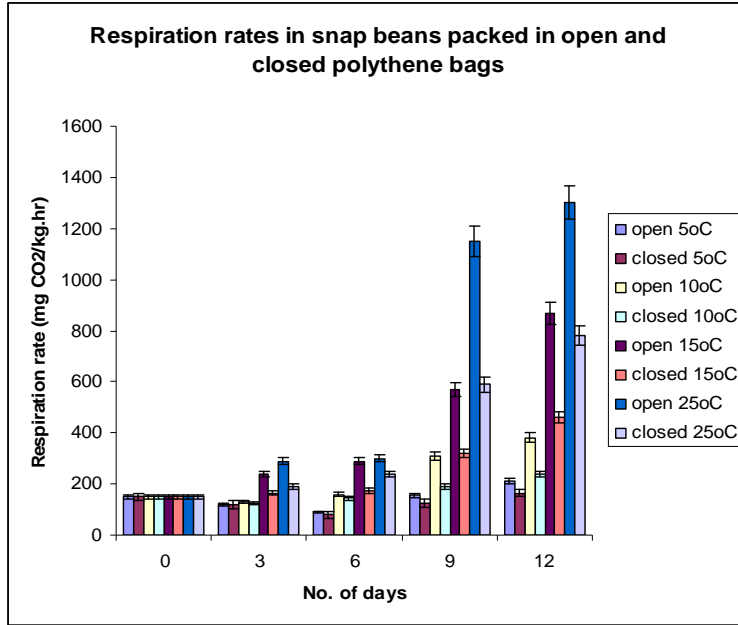


Figure 1: Respiration rate in snap beans packed in open polythene bags and closed polythene bags

It was also observed that the respiration rate was significantly lower ($p \leq 0.05$) in the closed polythene bags as compared to the open bags. The difference was even more marked at the higher temperature.

3.2 Weight Loss

The weight loss during the storage period is shown in Figure 2. The weight loss generally increased with the storage time. It was also noted to increase with increase in storage temperature. It was however noted that the increase was very low at 5°C. It was not significantly different ($p \leq 0.05$) between the sixth and twelfth days.

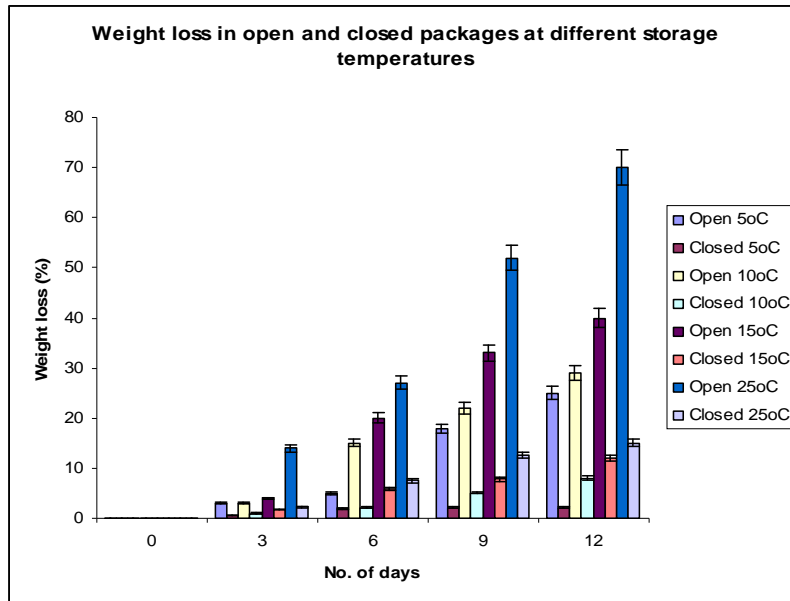


Figure 2: Weight loss (%) in snap beans packed in open polythene bags and closed polythene bags

At 10°C, the weight loss was quite low but significantly higher than at 5°C. It was also observed that the weight loss was significantly lower ($p \leq 0.05$) in the closed bags as compared to the open bags at all the temperatures and storage periods.

3.3 Chlorophyll Content

The results of chlorophyll content changes are shown in Figure 3. It was observed that there was a general decrease in chlorophyll content with increase in storage period. It was also noted that the decrease was more significant ($p \leq 0.05$) at the higher temperature. The decrease was lowest at 5°C where it remained almost constant for the entire period.

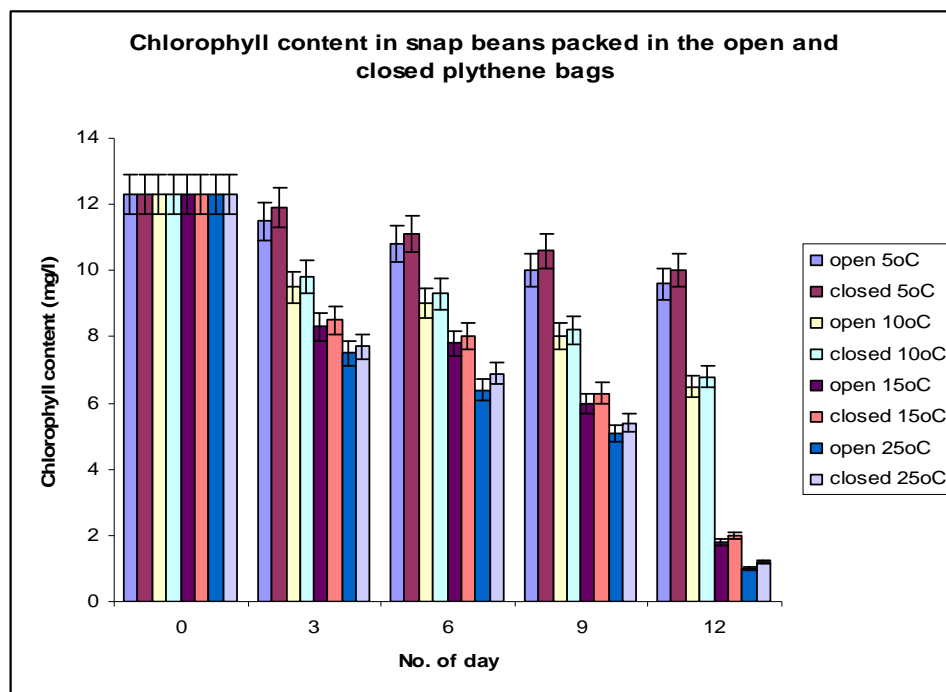


Figure 3: Change in chlorophyll content (mg/L) in snap beans packed in open polythene bags and closed polythene bags

The closed package was found to retain slightly more chlorophyll than the open packages though the greatest impact was due to both the storage temperature and period.

3.4 Total Soluble Solids

The results of total soluble solids are shown in Figure 4. There was a general decrease in total solids with the storage period. The loss was however significantly higher ($p \leq 0.05$) at both 15°C and 25°C. There were also significantly higher losses ($p \leq 0.05$) in the open packages than in the closed ones.

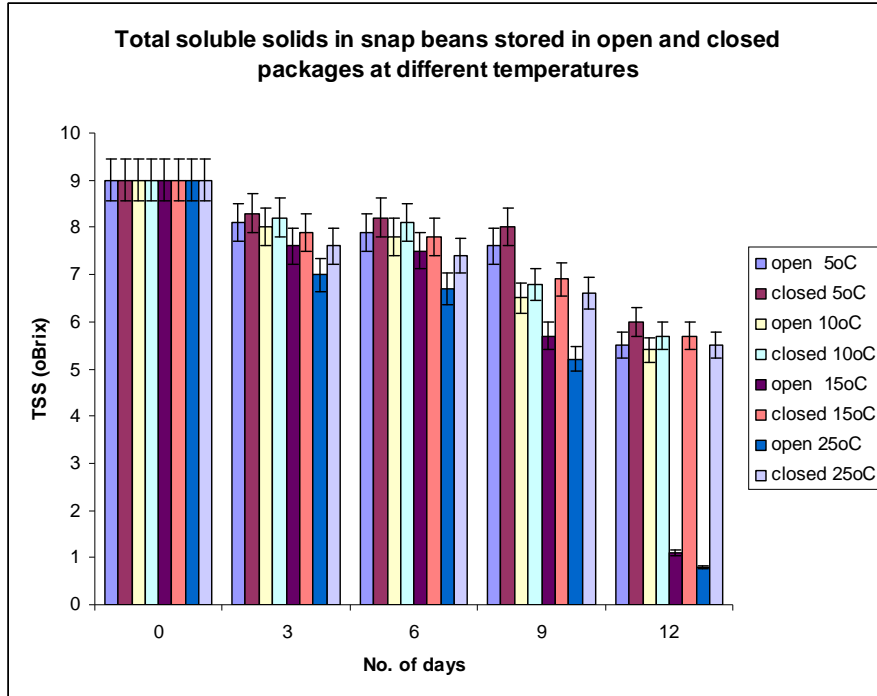


Figure 4: Total soluble solids (^oBrix) in snap beans packed in open polythene bags and closed polythene bags

3.5 Vitamin C Content

The results of vitamin C content are shown in Figure 5 below. Generally there was a reduction in vitamin C content with the storage period as similarly observed by Kaack (1994) The decrease was not significant within the first six days and especially for the lower storage temperatures. For both open and closed packages at 5°C, the vitamin C content remained almost constant.

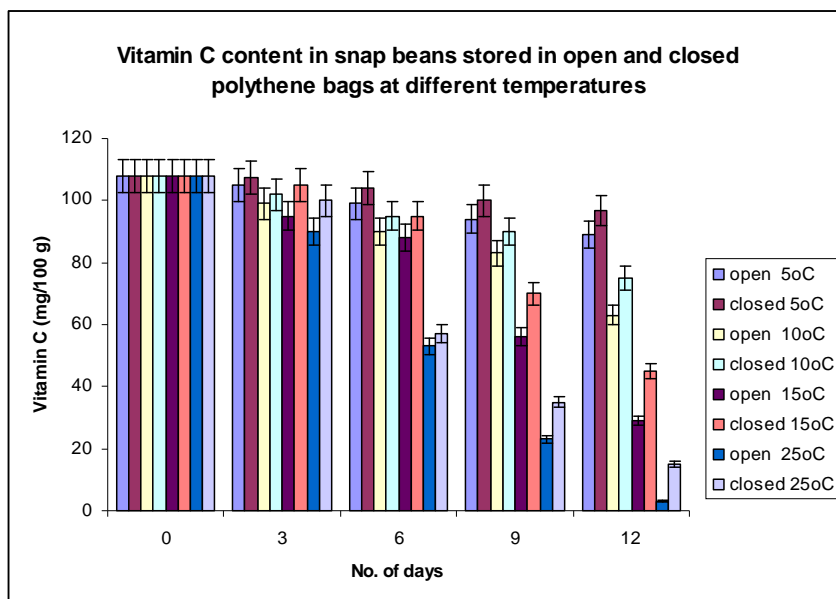


Figure 5: Change in Vitamin C content in snap beans packed in open polythene bags and closed polythene bags

Across the five parameters studied, it was observed that quality losses were lowest at 5°C and highest at 25°C. At 10°C, the losses were significant but reasonable. It can thus be suggested that the storage temperature of the snap beans should be at 5° or slightly higher than this to lower the energy consumption costs. A temperature of about 7°C would be ideal. The closed package was also found to significantly lower the rate of deterioration as assessed by the changes in the five parameters studied. A combination of both 5°C and closed package had the greatest preservation effect.

4.0 Conclusion

In conclusion a combination of low temperature storage and closed polythene packaging has a very good preservation effect on the quality of snap beans.

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