BIBLIOGRAPHY

VILLASI, SHERLY J. APRIL 2012. Shelf- Life of French Beans '*Claudine*' As Affected By Different Packaging Materials and Age of Coconut Water As Pre-Storage Treatment. Benguet State University, La Trinidad, Benguet

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ABSTRACT

The study was conducted to assess the shelf life of french beans as affected by different packaging material and age of coconut water.

Results show that french beans dipped in young coconut water and packed in styrofoam with polywrap significantly showed lower weight loss, better visual quality rating, longer days to yellowing and had longer shelf life.

Significant interaction effect were observed on the average weight loss and visual quality rating on the first and last week; and total weight loss of french beans as affected by different packaging materials and age of coconut water as pre-storage treatment.

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INTRODUCTION

Reduction of postharvest losses reduces cost of production, trade and distribution, lowers the price for the consumer and increases the farmer's income.

Proper postharvest processing and handling is an important part of modern agricultural production. Postharvest processes include the integrated functions of harvesting, cleaning, grading, cooling, storing, packaging, transporting and marketing. The technology of postharvest handling bridges the gap between the producer and the consumer - a gap which is often of time and distance. Utilizing improved postharvest practices often results in reduced food losses, improved overall quality and food safety, and higher profits for growers and marketers (Panhwar, 2006).

Rapid deterioration of vegetables after harvest can also be controlled by using growth regulators like cytokinin.Cytokinins delay ageing of plant organs by controlling protein synthesis and mobilization of resources. Cytokinins are applied to the marketed vegetables, cut shoots and flowers to keep them fresh for several days.

The study on postharvest handling will help the traders as well as the farmers to preserve and maintain the quality of their crops after harvest and during storage. It will also minimize economic losses and make supply and price stable. It is important to identify packaging materials and containers while the commodities are on display that would minimize postharvest losses. Appropriate packaging containers would therefore ensure better postharvest qualities of vegetable that would attract consumers in the market.

Objectives of the Study

The study was conducted to:

1. evaluate the effect of packaging materials on the shelf-life of french beans

2.evaluate the effect of coconut water as pre-storage treatment on the shelf life of french beans

3. determine the appropriate packaging material that will preserve the field fresh quality of french beans during display; and

4. determine the appropriate age of coconut water as pre-storage treatment on the shelf-life of frenchbeans.

Place and Time of the Study

The study was conducted at AC 105, College of Agriculture, Benguet State University, La Trinidad Benguet from December 2011 to January 2012.

REVIEW OF RELATED LITERATURE

Losses of horticultural produce are a major problem in the post-harvest chain. They can be caused by a wide variety of factors, ranging from growing conditions to handling at retail level. Not only are losses clearly a waste of food, but they also represent a similar waste of human effort, farm inputs, livelihoods, investments and scarce resources such as water (Wales, 2011).

Postharvest handling is the ultimate stage in the process of producing quality fresh fruits and vegetables. Vegetables and fruit are living organisms that continue to change after harvest. While some of these changes are desirable, most are not, and growers must be aware of effective ways to minimize undesirable changes, increase shelf life, and decrease postharvest losses. For most vegetables, maintaining cool temperatures and high humidity are the most effective means of preserving quality(Petzoldt, 2010).

The important consideration to postharvest handling and storing the different crops is to prolong the time which the commodity would be usable in fresh condition. For the producers and dealers, their concern is to prolong the freshness and storage ability of the produce for increased returns (Deanon, 1976). Packaging fresh fruits and vegetables is one of the most important steps in the long and complicated journey from grower to consumer. Bags, crates, hampers, baskets, cartons, bulk bins, and palletized containers are convenient containers for handling, transporting, and marketing fresh produce (Boyette, 2011).

The use of consumer packages is important in the marketing of fresh vegetables. Packages protect the product against dust and dirt and reduce losses due to dehydration or bruising from handling by customers. Packages should also provide information about the product, including the grade, handling instructions, and appropriate storage temperatures when the product is on display. The cost of the packaging is important, including whether the container can be recycled or reused.Hardenburg states that the improvement of packaging has contributed greatly to more efficient marketing. Packaging certainly affects appearance of product (as cited by Dao-anis, 2004).

Consumers always recommend clean, attractive and fresh produce but products do not usually cope with the demand because of postharvest and preharvest handling of producers. Current studies show that 20-70% of vegetable go to waste due to improper handling and 42% from vegetable and from fruits are wasted due to decay, over-ripening, injuries, weight loss, trimming and sprouting.

Pantastico states that storage of products prolongs usefulness and in some cases maintains their quality. Storage life maybe prolonged by proper control and management of postharvest diseases, regulation of temperature, etc. (Lonogan, 2004).

Ware (1973) stated that loss from rot or decay is entirely different from physiological shrinkage and it is often much more serious from an economic stand point. He also stated that most vegetable loss from decay organisms is lessened as temperature is lowered with a few exceptions.

Loss of moisture can be often minimized with protective wrappers to supplement the benefits of high humidity (Anon., 1977). Plastic material such as polyethylene film can be used for consumer size wrapping to protect stored commodities. Such moisture proof materials retard the loss of water from commodities to the atmosphere. On the other hand, plastic materials if sealed and tightly tied may restrict carbon dioxide and oxygen transfer as well as water vapor.

Panganiban stated that tin cans, polyethylene bag, cellophane bag and glass bottles are packaging materials that can be used singly or in combination base on functional efficiency and aesthetic appeal (as cited by Lonogan, 2004).

Andadswamy and Iyengar reported that consumer packing on film bags or over wrapped trays can increase the shelf life of some kinds of produce under both refrigerated and non-refrigerated conditions. Decay, moisture loss, mechanical damage may be reduced. Studies showed increase shelf-life for beans, pepper and mangoes when packed in film held at room temperature (as cited by Lacanaria, 1986).

Most fruits and vegetables keep best with minimum wilting under relative humidity of 90 to 95%. Work and Carew reported that loose packing will damage vegetable than tight packing. Vegetable should be packed properly to minimize damages during transit period. Packing and proper handling require efficient containers to protect products from bruising, vibrations and the weight of other stocked containers (as cited by Rimando, 1986).

Polystyrene also known as styrofoamis also used as packaging material. It cradles your fruit, vegetables, eggs and meat to keep them fresh and intact. It is an excellent low-cost and sanitary choice for food service packaging. It protects valuable shipments without adding significant weight. Polystyrene protects against moisture and maintains its strength and shape even after long periods of time**.** Polystyrene is sanitary, sturdy, efficient, economical and convenient (Anon., 2011).

Plastic twine is also used because it is strong and durable, chemical resistance, available in attractive color, available in reasonable price range and suitable packaging with brand and net (Dhoraji, 2011).

The quality of vegetable rapidly deteriorates after harvest. This can be controlled by application of cytokinin, gibberellic acid and auxins. These growth regulators have hormonal control in prolonging market acceptability of cut flower, fresh fruits and vegetables because of their capacity to reduce rate. Mothes stated that cytokinin is one of the recognized hormones found effective to improve crop production. It has the ability to attract large number of substance to prevent movement of leaf components on the treated area. This was supported by Krishmorthy as cited by Cabansi (2005) that a drop of kinetin in senescing leaf, the treated area remained green while the surrounding leaf tissue soon turned yellow.Mothes stated that kinetin is not only effective in maintaining the green condition in the treated area but also mobilize tagged amino acids from remote parts of the leaf.

Weaver as cited by Ciano (1983) stated that cytokinins and plant growth retardants delay senescence in vegetable and offer an additional means of forestalling loss of quality of perishable crops. Application of these chemical compounds to green vegetable may delay the usual manifesting of senescence that appears during storage.

Wareing and Philips (1970) stated that cytokinins are found to increase the rate of RNA and protein synthesis. Protein degradation leads to the accumulation of amino acids and amides in the leaf because they cannot be exported although there may be accumulation at the base of the petiole.

Previous study have shown that coconut water is a rich and excellent natural source of cytokinin readily available which is an effective substance in improving crop yield and quality promoting uniform germination, flower initiation, fruit development, color and size. It can also delay senescence by inhibiting the degradation of protein and chlorophyll content of the plant (PCARR, 1975). However Devlin (1977) explained that cytokinins, if applied in proper strength are able to retain their chlorophyll content and protein RNA levels. There is also an apparent enhancement of photosynthesis and high rate of photosynthesis.

Otculanas cited by Niroula (1993) also found that in Chinese cabbage, coconut water at 2-5 1/5 gal water enhanced head formation, effected high market yield and prolonged the postharvest quality of the commodity.

The Philippine Council of Agricultural Research (PCARR) (1975)as cited by Banson and Velasco (1983) coconut water does not only affect the growth and vegetative development of the rice plants but it is also essential for growth and development of very young natural embryos as reported by Overbeek (1941).

MATERIALS AND METHODS

Materials

The materials used werefrench beans, coconut water (young, green mature and brown mature),polyethylene plastic bags (sandobags, clear plastic bags),styrofoam,polywrap,plastic twine, sensitive weighing balance and labeling materials.

Methods

French beans were dipped on 3 liters of different age of coconut water following the treatments for 30 minutes and it was air dried for an hour before it was packed in the different packaging containers.

The treatments were laid out in a Factorial Completely Randomized Design (FCRD) with three replications. The treatments were as follows:

Factor A	Packaging Material
T_1	Styrofoam with polywrap
T_2	PEP (clear) with holes
T_3	PEP (sandobag)
T_4	Tied withplastic twine

Factor B	Coconut Water As Pre-Storage Treatment
B_1	no dipping (control)
B_2	dip in young coconut water (flesh is still thin and easily scraped)
B_3	dip in green mature coconut water (flesh is used for salad)

B_4	brown mature coconut water

Data Gathered

1. Average weight loss (g). The weight was taken daily and subtracted from the weight of the preceding day up to the termination date.

2. Visualquality rating. The visual quality rating of the pods were taken daily using the following rating.

Rating	Visual Quality
5- Excellent	Field Fresh
4- Very Good	Slight defects
3- Good	25% yellowing of pods
2- Fair	50% yellowing of pods
1- Poor	Onset of senescence, non-consumable, non- marketable

3.Days to shriveling. This was the number of days covered from display until 50 % of the samples shriveled.

4.Days to yellowing. This was the number of days covered from display until 50 % of the samples exhibits yellowing.

Days to initial rotting. This was the number of days from storage to occurrence of rot (i.e. black rot, gray mold rot).

6.Shelf life (days). This was the number of days covered from the time of display to the time that the condition factors were at least 50% visible enough for non-acceptability of the produce or unfit for human consumption.

7.Total weight loss (g). This was taken by subtracting the weight of the frenchbeans at the termination of the study from the initial weight.

8. Documentationof the study through pictures.

RESULTS AND DISCUSSION

Average Weight Loss

Effect of packaging container. Highly significant differences were observed on the average weight loss of french beans as affected by different packaging materials. French beans tied in plastic twine have the highest average weight loss as compared to the other treatments used.

Weight loss is generally due to the loss of water, otherwise known as transpiration and a little part of it is also due to the process of respiration. Commodities that are exposed to ambient condition transpire rapidly compared to commodities that are packed in sealed containers. Sealed packing is equivalent to modified atmosphere resulted to slow respiration rate of the french beans. Carbon dioxide accumulates in the cells to a level that retards metabolism. Plastic material if sealed or tightly tied, may restrict carbon dioxide and oxygen transfer, as well as water vapor (USDA, Handbook No.66).

Effect of coconut water. French beans that were not dipped in coconut water before packaging and storage had the highest average weight loss which is highly significant over the other treatments.

French beans dipped in coconut water before packaging had lower weight loss because coconut water contains a variety of nutrients including vitamins, minerals, antioxidants, amino acids, enzymes, growth factors, and other nutrients. It is particularly rich in potassium, an essential nutrient which retards senescence.

Table 1. Average weight loss

TREATMENT	MEAN (g)
Packaging Container	
Styrofoam with polywrap	0.34[d]
PEP (clear)with holes	1.28[c]
PEP (sandobag)	2.40[b]
Tied with plastic twine	14.09[a]
Coconut WaterAs Pre- Storage Treatment	
No dipping	4.98[a]
Dipped in young coconut water	4.35[c]
Dipped in green mature coconut water	4.79[b]
Dipped in brown mature coconut water	4.44[c]

Means with a common letter are not significantly different at 5% by DMRTcv=3.47%

Interaction effect. Highly significant differences were observed in the interaction effect of packaging container and coconut water on the average weight loss of french beans as shown in Figure 1.French beans tied with plastic twine that werenot dipped in coconut water had the highest average weight loss and it was significantly different from french beans packed in styrofoam with polywrap that were dipped in young coconut water which has the lowest average weight loss.

The aboveresults were due to the fact that transpiration is retarded by packing commodities in sealed containers. Coconut water contains cytokinin, a plant regulator that is known to retard senescence in plant tissue.

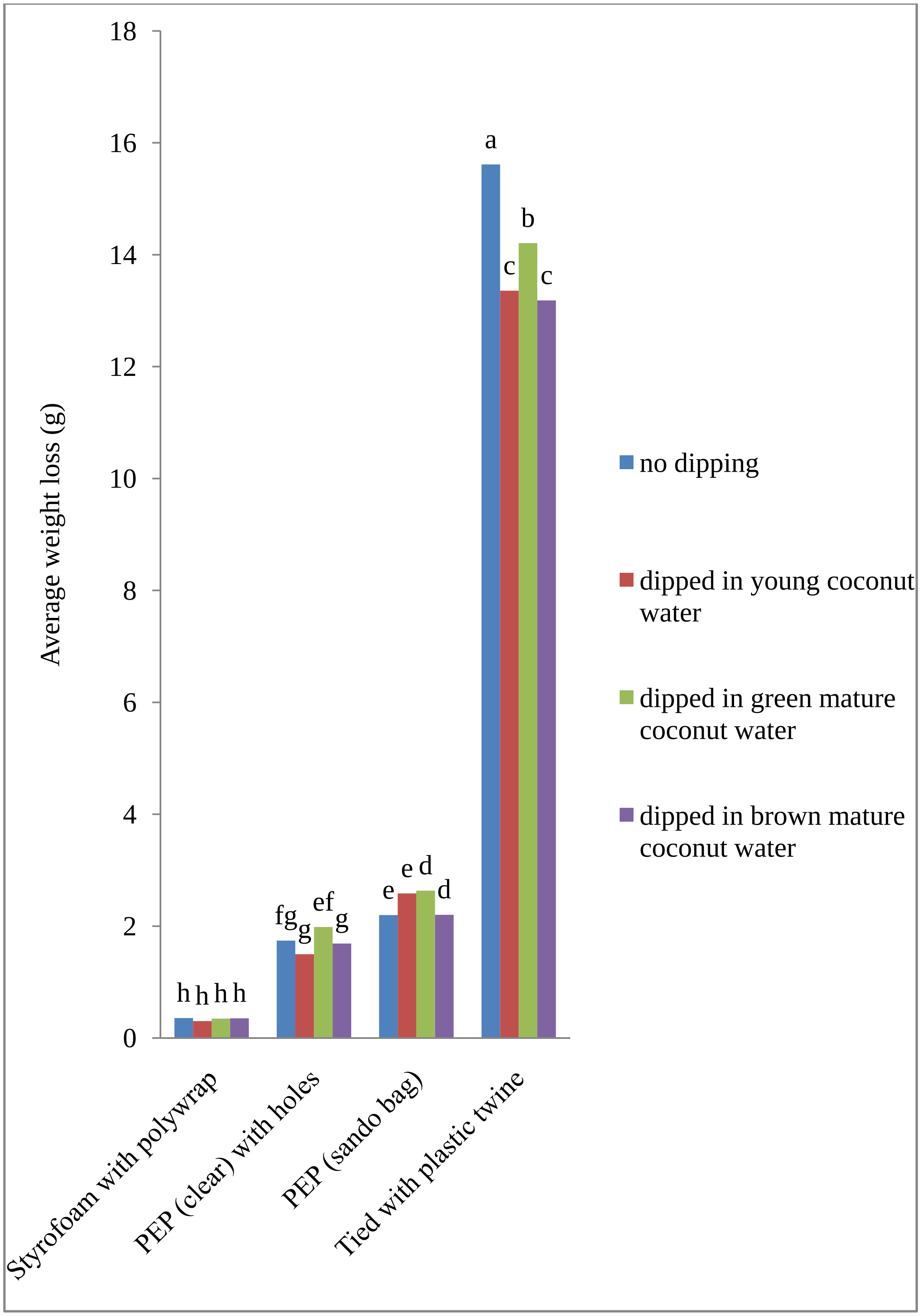

Figure 1. Effect of pre-storage coconut water and packaging material on the average weight loss of french beans.

Visual Quality Rating

Effect of packaging container. The visual quality ratings of french beans from the start until the termination of the study were highly significant as affected by the different packaging container. It was found that french beans packed in styrofoamhad excellent visual quality rating recorded throughout the duration of the study.

The styrofoam protected the commodity from physical damage which affect external and internal appearance.

General appearance and quality of french beans were influenced by different conditions like decay, shriveling and discoloration during display.

Effect of coconut water.The age of coconut water was found to be highly significant on the visual quality rating of french beans from the first to the last week of the experiment. Dipping of french beans in young coconut water showed very good appearance throughout the study but it was not significantly different with french beans dipped in brown mature coconut water during the second and last week of the study.

Cytokinin application markedly reduces the extent and rate of chlorophyll and protein degradation and leaf drop correlation between cytokine levels and senescence. Ordinarily a senescing leaf turns yellow as chlorophyll is degraded, but cytokinin appear to active a number of metabolic process at the site of the application and inhibit chlorophyll breakdown.

Table 2. Visual quality rating

TREATMENT	VISUAL QUALITY RATING		
	FIRST WEEK	SECOND WEEK	LAST WEEK
Packaging Container			
Styrofoam with polywrap	5.00[a]	4.49[a]	3.09[a]
PEP (clear) with holes	4.73[b]	3.63[b]	2.19[b]
PEP (sando bag)	4.54[c]	3.74[b]	2.19[b]
Tied with plastic twine	3.80[d]	2.04[c]	2.00[b]
Coconut Water As Pre-Storage Treatment			
No dipping	4.35[d]	3.25[b]	2.14[c]
Dipped in young coconut water	4.64[a]	3.70[a]	2.58[a]
Dipped in green mature coconut water	4.47[c]	3.25[b]	2.29[bc]
Dipped in brown mature coconut water	4.61[b]	3.70[a]	2.47[ab]
	cv= 0.80%	cv= 10.59%	cv= 10.15%

In a column, means with a common letter are not significantly different at 5% by DMRT

Interaction effect. Theeffect of packaging container and coconut water on the visual quality rating of french beans during the first (Figure 2) and last week (Figure 3) of observationswere highly significant while on the second week of observations there were no significant differencesrecorded. Results revealed that french beans packed in styrofoamboxes that were dipped in young coconut water had very good appearance at the termination of the study.

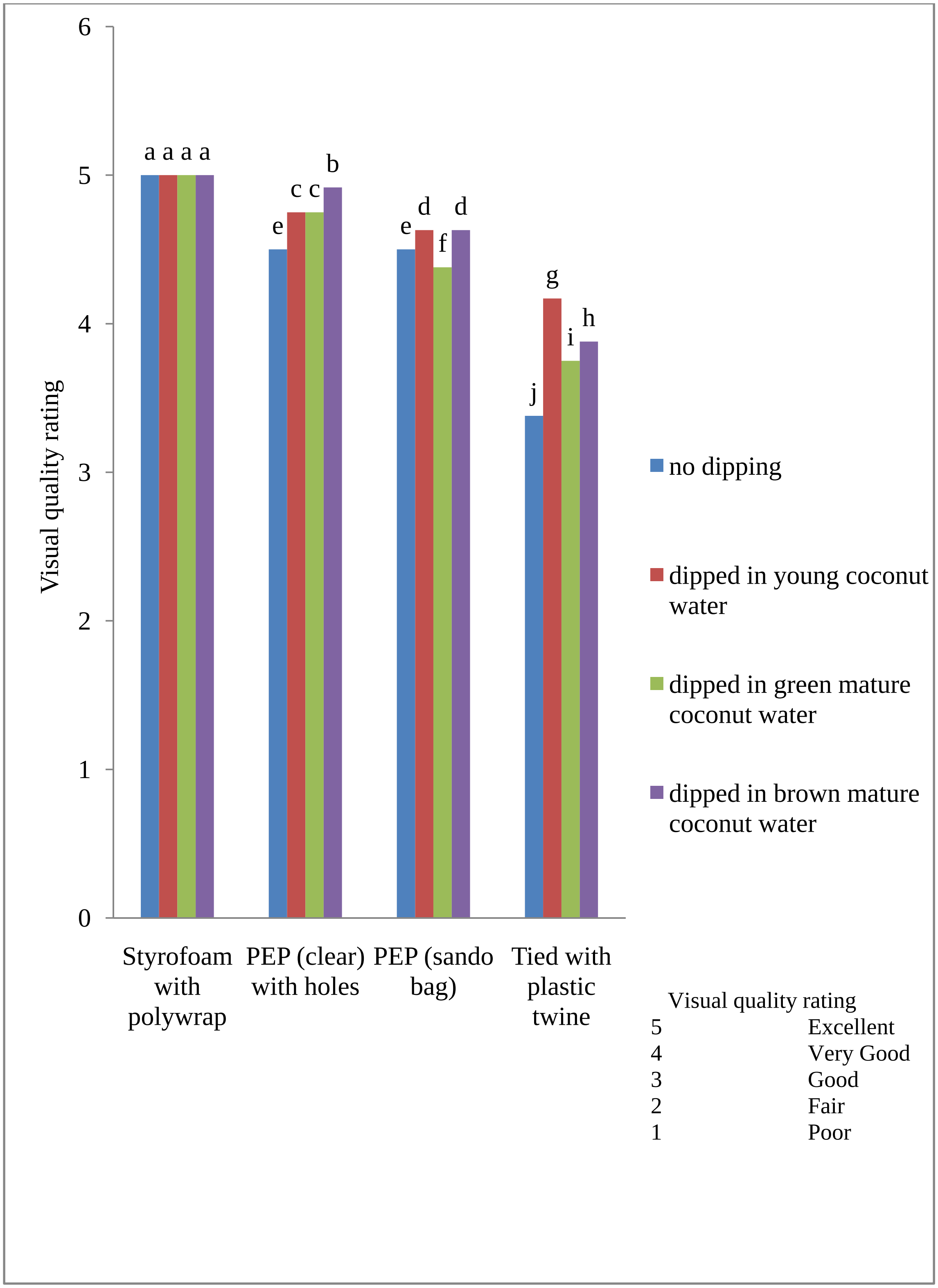

Figure 2.Visual quality rating of french beans on the first week of observation as affected by packaging material and age of coconut water as pre-storage treatment.

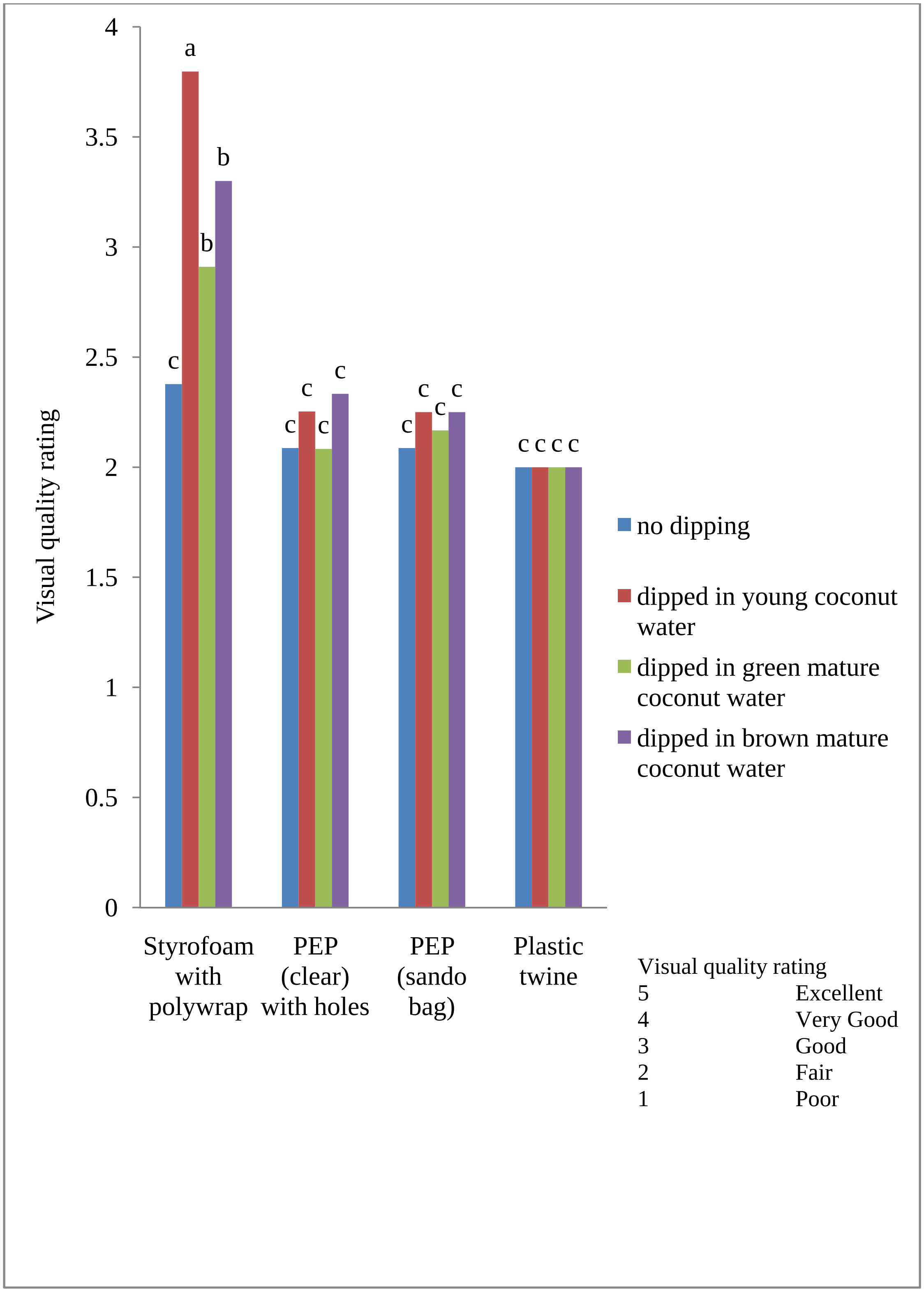

Figure 3.Visual quality rating of french beans on the last week of observation as affected by packaging material and age of coconut water as pre-storage treatment.

Days to Shriveling

Effect of packaging container. French beans tied with plastic twine were the earliest to shrivel which is highly significant among the treatments.

Many fruits, vegetables, and flowers become shriveled after losing only a small percentage of their original weight due to water loss(http://www.ces.ncsu.edu/depts/hort/hil/hil-800.html). The resulting loss of moisture causes the cell walls to collapse resulting in the fruit or vegetable to shrivel up. During postharvest handling and storage, fresh fruits and vegetables lose moisturethrough their skins via the transpiration process. Commodity deterioration, such as shriveling or impaired flavor, may result if moisture loss is high. In order to minimize losses due to transpiration, and thereby increase both market quality and shelf life, commodities must be stored in a low temperature, high humidity environment(Becker and Fricke, 2012).

Effect of coconut water. The differences obtained on the days to shriveling among the treatments did not differ significantly as affected by the age of coconut water as pre-storage treatment.

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Table 3. Days to shriveling

TREATMENT	MEAN
Packaging Container	
Styrofoam with polywrap	0.00[c]
PEP (clear) with holes	1.50[c]
PEP (sando bag)	17.42[a]
Plastic twine	7.75[b]
Coconut WaterAs Pre-Storage Treatment	
No dipping	7.17[a]
Dipped in young coconut water	6.75[a]
Dipped in green mature coconut water	6.08[a]
Dipped in brown mature coconut water	6.67[a]

Means with a common letter are not significantly different at 5% by DMRTcv=40.56%

Interaction effect.No significant differences were observed on days to shriveling of french beansas affected by packaging container and different maturities of coconut water.

Days to Yellowing

Effect of packaging container. Results revealed highly significant differences on the packaging container on the days to yellowing. Results show that french beans packed in styrofoamwith polywrapwas the latest to attain yellowing.

As mentioned earlier, the french beans were sealed in the styrofoam thus protecting it from physical damage which causes change in color of the commodity.

Effect of coconut water. Highly significant differences were observed among the treatments. French beans dipped in young coconut water were the latest to attain yellowing from display but was not significantly different with french beans dipped in brown mature coconut water.

Observation showed that coconut water can somehow delay yellowing of french beans due to its cytokinin content. This was supported by the statementof Wingler(1998) that cytokinins have been known to slow the aging of plant organs. This process occurs by preventing protein breakdown, activating protein synthesis, and assembling nutrients from nearby tissues. In a study that regulated leaf senescence in tobacco leaves, it was found that wild-type leaves showed yellowing of leaves, while the transgenic leaves remained mostly green. It was hypothesized that cytokinin may affect enzymes that regulate protein synthesis and degradation thus delaying earlier yellowing of french beans. Cytokinins are particularly abundant in embryos of young fruits and in roots in green or active form as a component of t- RNA. They are active in regulating protein synthesis probably by turning gene transpiration on and off or acting through t- RNA to control translocation of gene product (as cited by Cabansi, 2005).

Table 4. Days to yellowing

TREATMENT	MEAN
Packaging Container	
Styrofoam with polywrap	21.83[a]
PEP (clear) with holes	17.00[b]
PEP (sando bag)	17.42[b]
Plastic twine	13.75[c]
Coconut WaterAs Pre-Storage Treatment	
No dipping	15.92[b]
Dipped in young coconut water	18.83[a]
Dipped in green mature coconut water	16.58[b]
Dipped in brown mature coconut water	18.67[a]

Means with a common letter are not significantly different at 5% by DMRTcv=9.48%

Interaction effect.Packaging container and coconut water were found to be not significant on days to yellowing.

Days to Rotting

Effect of packaging container.The difference obtained on the number of days to rotting of french beans were significantly different as affected by packaging container. French beans packed in styrofoam with polywrap gave the longest number of days to rotting but were not significantly different with those packed in polyethylene plastic bags (clear and sandobags).

Rotting was due to the accumulated moisture inside the container and high concentration of carbon dioxide which might have killed the cells, thus fascilitating the growth of microorganisms (as cited by Ciano, 1983).High temperature and relative humidity favor the growth of micro-organisms which cause extensive damage to the produce. High temperature also increases the rate of respiration in fruits and vegetables which subsequently leads to the breakdown of the inner tissues. Decaying of fruits and vegetables is increased by high temperature coupled with high relative humidity. The microbial attack to different crops becomes very slow at low temperature especially when it is below 5 °C (Chandy, 2012).

Effect of coconut water.There were no significant differences observed on the number of days to rotting of french beans as affected by the age of coconut water used as pre-storage treatment.

Interaction effect. There were no significant differences observed on the number of days to rotting of french beans as affected by packaging container and maturity of coconut water as pre-storage treatment.

Table 5. Days to rotting

TREATMENT	MEAN
Packaging Container	
Styrofoam with polywrap	10.08[a]
PEP (clear) with holes	9.17[a]
PEP (sando bag)	4.92[ab]
Plastic twine	0.00[b]
Coconut WaterAs Pre-Storage Treatment	
No dipping	8.33[a]
Dipped in young coconut water	4.58[a]
Dipped in green mature coconut water	7.75[a]
Dipped in brown mature coconut water	3.50[a]

Means with a common letter are not significantly different at 5% by DMRT cv=138.25%

Total Weight Loss

Effect of packaging container. Statistically, highly significant differences were observed from among the treatment means. French beans packed in plastic twine showed the highest weight loss among the treatments. Loss of weight is due to transpiration and loss of carbon in respiration.

Packaging of fresh fruits and vegetables has a great significance in reducing the wastage. Packaging also provides protection from mechanical damage, undesirable physiological changes and pathological deterioration duringstorage, transportation and marketing. Through properpackaging, freshness, succulence and flavor of fruits and

Table 6. Total weight loss

TREATMENT	MEAN (g)
Packaging Container	
Styrofoam with polywrap	7.44[d]
PEP (clear) with holes	29.07[c]
PEP (sando bag)	41.61[b]
Plastic twine	108.82[a]
Coconut WaterAs Pre-Storage Treatment	
No dipping	44.48[b]
Dipped in young coconut water	46.24[ab]
Dipped in green mature coconut water	48.01[a]
Dipped in brown mature coconut water	48.21[a]

Means with a common letter are not significantly different at 5% by DMRTcv= 5.28%

vegetables can be maintained for a longer period (Chandy, 2012).

Effect of coconut water. Highly significant differences on the total weight loss of french beans were observed as affected by the age of coconut water as pre-storage treatment. However, french beans dipped in brown mature coconut water gave the highest total weight loss but were not significantly different with french beans dipped in young and green mature coconut water as pre-storage treatment.

Interaction effect. Highly significant differences were observed on the interaction effects between the packaging container and age of coconut water as pre-storage treatment on the total weight loss of french beans. French beans tied with plastic twine that were dipped in green mature coconut water had the highest total weight loss which was significantly different with the other treatments used.

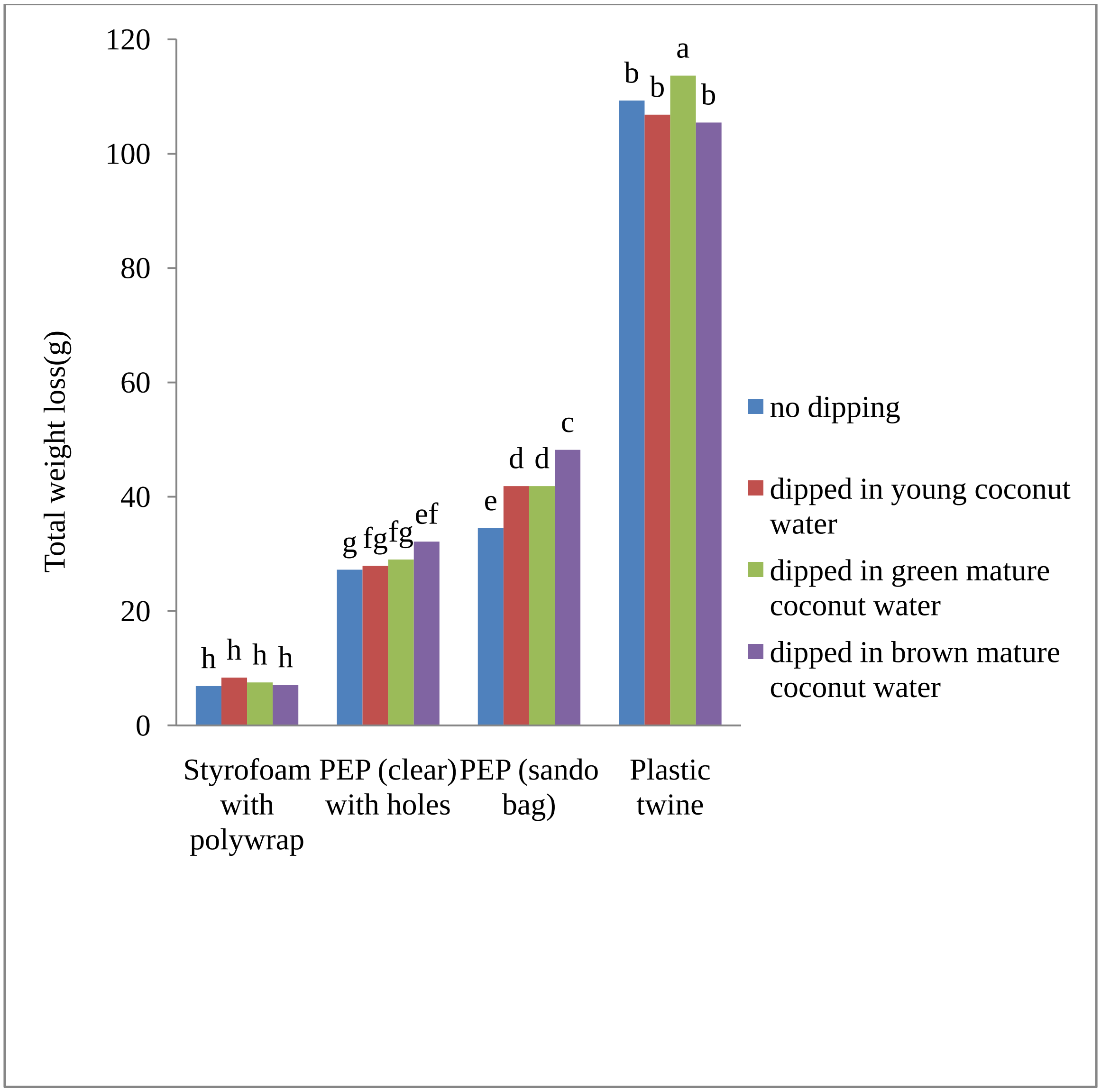

Figure 4.Total weight loss of french beans as affected by packaging material and age of coconut water as pre-storage treatment.

Shelf Life

Effect of packaging container. French beans packed in styrofoam with polywrap had the longest shelf life which was highly significant over the other treatments. Styrofoamhas high moisture resistance and low vapor transmission thus prolonging the shelf life of french beans.

Effect of coconut water. Result shows that differences among the treatments were highly significant.However, dipping of french beans in young coconut water did not differ significantly with brown matured coconut water.Cytokinin act on some enzymes responsible for the formation of certain amino acid and increase sink activity thus inhibits the breakdown of protein during senescence (Anon., 2012).

Interaction effect.The combined effects of packaging container and coconut water on the shelf life of french beans were not significant.

Table 7. Shelf life

TREATMENT	MEAN (days)
Packaging Container	
Styrofoam with polywrap	21.83[a]
PEP (clear) with holes	17.00[b]
PEP (sando bag)	17.42[b]
Plastic twine	7.75b[c]
Coconut WaterAs Pre-Storage Treatment	
No dipping	14.42[b]
Dipped in young coconut water	17.33[a]
Dipped in green mature coconut water	15.08[b]
Dipped in brown mature coconut water	17.17[a]

Means with a common letter are not significantly different at 5% by DMRT cv=10.36%

a.Styrofoam and polywrap

b. PEP (clear) with holes

c.PEP (sando bag)

d. Plastic twine

Plate 1. Overview of the different packaging materials used.

a.French beans packed in styrofoam with polywrap

b. French beans tied with plastic twine

c. French beans packed in PEP (sando bag)

d. French beans packed in PEP (clear) with holes

Plate 2. Overview of french beans packed in the different packaging materials.

Plate 3.Overview of the experiment during display.

Plate 4. Overview of the french beans packed in styrofoam with polywrap (a) and PEP (clear) with holes (b) at termination of observation.

Plate 5. Overview of the french beans packed in PEP (sandobag) (a) and tied in plastic twine (b) at termination of observation.

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The study was conducted at AC 105, College of Agriculture, Benguet State University, La Trinidad Benguet on December 2011 to evaluate the effect of packaging materials and coconut water on the shelf life of french beans and to determine the appropriate packaging material and maturities of coconut water that preserves the field freshquality offrench beans during display.

Results show that french beans packed in styrofoam with polywraphad highly significant lower weight loss, better visual quality rating, and longer days to shriveling, yellowing, rotting and longer shelf life from treatment up to termination date.

The effect of coconut water on the weight loss, visual quality rating, days to yellowing and shelf life were highly significant. However, there were no significant differences noted on the days to shriveling and rotting.

Highly significant interaction effects were only observed on the weight loss and visual quality rating of the french beans. No significant differences were observed on the days to shriveling, yellowing, rotting and shelf life of french beans as affected by packaging material and coconut water.

From the observation, french beans packed in styrofoam with polywrap that were dipped in young coconut water for thirty minutes had the longest shelf life with lesser defects.

Conclusion

Findings shows that theuse of styrofoam with polywrap and dipping it in young coconut water for 30 minutes prolongs the shelf life of french beans.

Recommendation

To ensure better quality and to lengthen the shelf life of french beans, it is recommended that it should be dipped in young coconut water for 30 minutesas pre-storage treatment before packing in styrofoam with polywrap.

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APPENDICES

Appendix Table 1. Average weight loss (g)

TREATMENT	REPLICATION I	II	III	TOTAL	MEAN (g)
T1B1	0.38	0.36	0.33	1.07	0.36
B2	0.37	0.38	0.31	1.06	0.35
B3	0.37	0.37	0.3	1.04	0.35
B4	0.3	0.30	0.31	0.91	0.30
T2B1	1.75	1.72	1.75	5.22	1.74
B2	1.51	1.51	1.47	4.49	1.50
B3 1.99		2.04	1.92	5.95	1.98
B41.74		1.65	1.68	5.07	1.69
T3B1	2.34	2.25	2.00	6.59	2.20
B2	2.22	2.19	2.20	6.61	2.20
B3	2.36	2.23	3.31	7.90	2.63
B4	2.53	2.55	2.67	7.75	2.58
T4B1	15.57	15.63	15.64	46.84	15.61
B2	13.35	13.28	13.44	40.07	13.36
B3	14.15	14.21	14.26	46.62	14.21
B4	13.29	13.1	13.16	38.55	13.18

Analysis of Variance

Source of Variation	Degreesof freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	0.01
Factor A	3	1455.29	485.10	18690.50**	2.90	4.46
Factor B	3	3.11	1.04	39.96**	2.90	4.46
AxB	9	8.84	0.98	37.85**	2.19	3.02
Error	32	0.83	0.03			
Total	47	1468.07				

**= Highly significant Coeffecient of variation=3.47%

Appendix Table 2. First week of visual quality rating

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T1B1	5.00	5.00	5.00	15.00	5.00
B2	5.00	5.00	5.00	15.00	5.00
B3	5.00	5.00	5.00	15.00	5.00
B4	5.00	5.00	5.00	15.00	5.00
T2B1	4.50	4.50	4.50	13.50	4.50
B2	4.75	4.75	4.75	14.25	4.75
B3	4.75	4.75	4.75	14.25	4.75
B4	5.00	4.75	5.00	14.75	4.92
T3B1	4.50	4.50	4.50	13.50	4.50
B2	4.63	4.63	4.63	13.89	4.63
B3	4.38	4.38	4.38	13.14	4.38
B4	4.63	4.63	4.63	13.89	4.63
T4B1	3.38	3.38	3.38	10.14	3.38
B2	4.17	4.17	4.17	12.51	4.17
B3	3.75	3.75	3.75	11.25	3.75
B4	3.88	3.88	3.88	11.64	3.88

Analysis of Variance

Source of Variation	Degreesof freedom	Sum of squares	Mean square	Computed F	TABULAR F	
					0.05	0.01
FACTORA	3	9.59	3.20	2457.27**	2.90	4.46
FACTOR B	3	0.65	0.22	166.91**	2.90	4.46
AxB	9	0.71	0.08	60.57**	2.19	3.02
ERROR	32	0.04	0.00			
TOTAL	47	11.00				

**=Highly significant Coeffecient of variance=0.80%

Appendix Table 3. Second week of visual quality rating

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T1B1	4.25	4.38	4.25	12.88	4.29
B2	4.63	4.63	4.63	13.89	4.63
B3	4.38	4.38	4.00	12.67	4.25
B4	5.00	5.00	4.38	14.38	4.79
T2B1	3.89	3.89	2.25	10.03	3.34
B2	4.00	4.00	4.00	12.00	4.00
B3	2.75	2.75	4.00	9.50	3.17
B4	4.00	4.00	4.00	12.00	4.00
T3B1	3.50	3.50	3.13	10.13	3.38
B2	4.00	4.00	4.00	12.00	4.00
B3	4.00	4.00	2.75	10.75	3.58
B4	4.00	4.00	4.00	12.00	4.00
T4B1	2.00	2.00	2.00	6.00	2.00
B2	2.17	2.17	2.17	6.51	2.17
B3	2.00	2.00	2.00	6.00	2.00
B4	2.00	2.00	2.00	6.00	2.00

Analysis of Variance

Source of Variation	Degreesof freedom	Sum of squares	Mean square	Computed F	TABULAR F	
					0.05	0.01
Factor A	3	38.17	12.72	93.99**	2.90	4.46
Factor B	3	2.39	0.80	5.91**	2.90	4.46
AxB	9	0.87	0.09	0.72^{ns}	2.19	3.02
Error	32	4.33	0.14			
Total	47	45.77				

**= Highly significant

ns= Not significant

Coeffecient of variance= 10.59%

Appendix Table 3. Third week of visual quality rating

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T1B1	2.50	2.50	2.13	7.13	2.38
B2	4.13	4.13	3.13	11.39	3.80
B3	3.30	3.30	2.13	8.73	2.91
B4	3.30	3.30	3.30	9.90	3.30
T2B1	2.13	2.13	2.00	2.26	2.09
B2	2.25	2.50	2.25	7.00	2.33
B3	2.00	2.00	2.25	6.25	2.08
B4	2.25	2.13	2.38	6.76	2.25
T3B1	2.13	2.13	2.00	6.26	2.09
B2	2.25	2.25	2.25	6.75	2.75
B3	2.25	2.25	2.00	6.50	2.17
B4	2.25	2.25	2.25	6.75	2.25
T4B1	2.00	2.00	2.00	6.00	2.00
B2	2.00	2.00	2.00	6.00	2.00
B3	2.00	2.00	2.00	6.00	2.00
B4	2.00	2.00	2.00	6.00	2.00

Analysis of Variance

Source of Variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F	
					0.05	0.01
FACTOR A	3	8.75	2.92	50.49**	2.90	4.46
FACTOR B	3	1.35	0.45	7.80**	2.90	4.46
AxB	9	2.10	0.23	4.03**	2.19	3.02
ERROR	32	1.85				
TOTAL	47	14.05				

**= Highly significant　　Coeffecient of variance= 10.15%

Appendix Table 4. Days to shriveling

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T1B1	0	0	0	0	0
B2	0	0	0	0	0
B3	0	0	0	0	0
B4	0	0	0	0	0
T2B1	0	18	0	18	6
B2	0	0	0	0	0
B3	0	0	0	0	0
B4	0	0	0	0	0
T3B1	16	16	15	47	15
B2	19	19	19	57	19
B3	18	18	13	49	16
B4	19	19	18	56	18
T4B1	7	7	7	21	7
B2	8	8	8	24	8
B3	8	8	8	24	8
B4	8	8	8	24	8

Analysis of Variance

Source of Variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	0.01
FACTOR A	3	2254.50	751.50	102.7692**	2.90	4.46
FACTOR B	3	7.17	2.39	0.3267^{ns}	2.90	4.46
AxB	9	101.00	11.22	1.5347 ^{ns}	2.19	3.02
ERROR	32	234.00	7.31			
TOTAL	47	2596.67				

**= highly significant
ns= Not significant

Coeffecient of variance= 40.56%

Appendix Table 5. Days to Yellowing

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T1B1	20	20	18	58	19.33
B2	24	24	23	71	23.67
B3	23	23	18	64	21.33
B4	23	23	23	69	23
T2B1	18	18	11	47	15.67
B2	19	18	19	56	18.67
B3	13	13	18	44	14.67
B4	19	19	19	57	19
T3B1	16	16	15	47	15.67
B2	19	19	19	57	19
B3	18	18	13	49	16.33
B4	19	19	18	56	18.67
T4B1	13	13	13	39	13
B2	14	14	14	42	14
B3	14	14	14	42	14
B4	14	14	14	42	14

Analysis of Variance

Source of Variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F	
					0.05	0.01
FACTOR A	3	397.17	132.39	48.14**	2.90	4.46
FACTOR B	3	77.83	25.94	9.43**	2.90	4.46
AxB	9	25.00	2.78	1.01^{ns}	2.19	3.02
ERROR	32	88.00	2.75			
TOTAL	47	588.00				

**= Highly significant

ns= Not significant

Coeffecient of variance= 9.48%

Appendix Table 6. Days to Rotting

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T1B1	0	20	18	38	12.67
B2	23	0	0	23	7.6
B3	0	18	18	36	12.00
B4	0	0	24	24	8.00
T2B1	18	18	11	47	15.67
B2	0	0	19	19	6.33
B3	13	13	0	26	8.67
B4	0	18	0	18	6.00
T3B1	0	0	15	15	5.00
B2	13	0	0	13	4.33
B3	0	13	13	31	10.33
B4	0	0	0	0	0
T4B1	0	0	0	0	0
B2	0	0	0	0	0
B3	0	0	0	0	0
B4	0	0	0	0	0

Analysis of Variance

Source of Variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F	
					0.05	0.01
FACTOR A	3	766.42	255.47	3.66*	2.90	4.46
FACTOR B	3	201.08	67.03	0.96^{ns}	2.90	4.46
AxB	9	203.75	22.64	0.32^{ns}	2.19	3.02
ERROR	32	2232.67	69.77			
TOTAL	47	3403.92				

*= significant

ns= Not significant

Coeffecient of variance= 138.25%

Appendix Table 7. Total Weight Loss (g)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		(g)
T1B1	7.50	7.10	6.00	20.60	6.87
B2	8.80	9.10	7.20	25.10	8.37
B3	8.60	8.50	5.40	22.50	7.50
B4	6.90	7.00	7.20	21.10	7.03
T2B1	31.50	31.00	19.20	81.70	27.23
B2	28.60	27.10	28.00	83.70	27.90
B3	25.90	26.50	34.60	87.00	29.00
B4	33.10	31.30	32.00	96.40	32.13
T3B1	37.40	36.00	30.10	103.50	34.50
B2	42.10	41.70	41.80	125.60	41.87
B3	42.50	40.10	43.00	125.60	41.87
B4	48.00	48.50	48.10	144.60	48.20
T4B1	109.00	109.40	109.50	327.90	109.30
B2	106.80	106.20	107.50	320.50	106.83
B3	113.20	113.70	114.10	340.80	113.60
B4	106.30	104.80	105.30	316.40	105.47

Analysis of Variance

Source of Variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	0.01
FACTOR A	3	68838.63	22946.21	3775.0825**	2.90	4.46
FACTOR B	3	109.72	36.57	6.0168**	2.90	4.46
AxB	9	335.82	37.31	6.1387**	2.19	3.02
ERROR	32	194.50	6.08			
TOTAL	47	69478.67				

**= Highly significant Coeffecient of variance= 5.28%

Appendix Table 8. Shelf Life (days)

TREATMENTS	REPLICATION			TOTAL	MEAN
	I	II	III		(days)
T1B1	20	20	18	58	19.33
B2	24	24	23	71	23.67
B3	23	23	18	64	21.33
B4	23	23	23	69	23.00
T2B1	18	18	11	47	14.67
B2	19	18	19	56	18.67
B3	13	13	18	44	14.67
B4	19	19	19	57	19.00
T3B1	16	16	15	51	17.00
B2	19	19	18	56	18.67
B3	18	18	13	49	16.33
B4	19	19	19	57	19.00
T4B1	7	7	7	21	7.00
B2	8	8	8	24	8.00
B3	8	8	8	24	8.00
B4	8	8	8	24	8.00

Analysis of Variance

Source of Variation	Degrees of freedom	Sum of squares	Mean square	Computed F	TABULAR F 0.05	0.01
FACTOR A	3	1261.17	420.39	152.87**	2.90	4.46
FACTOR B	3	77.83	25.94	9.43**	2.90	4.46
AxB	9	25.00	2.78	1.01^{ns}	2.19	3.02
ERROR	32	88.00	2.75			
TOTAL	47	1452.00				

**= Highly significant
ns= Not significant

Coeffecient of variance= 10.36%