Journal of Science and Technology, 7(1 & 2): 65-77, December 2017

PACKAGING MATERIALS AND STORAGE CONDITIONS FOR FRESH CUT CABBAGE

ROKEYA BEGUM*, MD. AZIZUL HAQUE, NARGIS AKTER, REBEKA SULTANA and MAHAMUDUL HASAN

Department of Food Technology and Nutritional Science, Mawlana Bhashani Science and Technology University, Tangail-1902, Bangladesh

Abstract

The work was conducted to evaluate the effect of packaging materials and storage conditions of fresh cut cabbage. Plastic pack with the thickness of 25, 50, 100 micron and foil paper were used as packaging material to store at ambient, refrigeration and freezing condition. Quality attributes-such as total weight loss, vitamin C content, conductivity, color, flavor, texture change of fresh cut cabbage during storage were evaluated to find the effect of factors. The freezing storage exhibited the maximum moisture loss during thawing but color and flavor remain acceptable till the 9th day of storage. Sample stored at normal condition showed off odor and slimy appearance on surface within 5th day of experiment. Cabbage stored in 100 micron plastic pack at refrigeration condition exhibited better sensory characteristics, lower weight loss, vitamin C loss and conductivity compared to other packaging materials and storage conditions. Bacterial and fungal growth also remained comparatively lower than other packaging materials.

Key words: Cabbage, fresh cut, packaging materials, vitamin C, conductivity

Introduction

Cabbage is one of the well-known vegetables in Bangladesh with high vitamin B, vitamin C, iron and healthy consumed. Generally, people prefer to consume fresh vegetable due to its valuable benefits. The goal of fresh cut products is to maintain the freshness of the product without any reduction on its nutrient content and extend the self-life of the product. According to King and Bolin (1989), fruits and vegetables which are processed by minimally-processing are the fruits and vegetables that prepared for easiness to be consumed and distribution. Cabbage is one of the commodities that prone to get damage and it needs proper handling after harvesting to ensure its quality till reaching the consumer. Storage temperature can prolong the shelf life of fresh vegetable (Jenny et al., 2008; Robert et al., 1999). Packaging also plays an important role in preventing the decaying process. Packaging not only plays a barrier property to protect the product from

* Corresponding author: rokeya15@yahoo.com

environmental obstacle and harmful germs and insects but also it works as a trade mark of their product (Highland, 1981). Several polymer types are currently used for foodstuff packaging to prevent the entrance of pests and contaminations (Allahvaisi, 2009). Based on above discussion, the current study was designed to know the quality of fresh cut cabbage during its storage at different temperature and different packaging material.

Materials and Methods

Study place

This study was conducted at the Laboratories of the Department of Food Technology and Nutritional Science during January to March 2017.

Sample collection and preparation

Cabbage was collected at optimum mature stage from local area of Santosh Bazar, Tangail, Bangladesh. Packaging material such as polyethylene of different width such as 25 micron, 50 micron, 100 micron and foil paper were used. After collecting the cabbage they were washed and shredded in same size by knife. About 50 gram shredded cabbage were immediately packaged in different packaging materials and sealed. All the packaging materials were sterilized by ultra violet ray at least 5 minutes before packaging. Prepared packets were stored at three different storage conditions such as; ambient condition (normal temperature); refrigeration condition (3-7°C) and freezing condition (-18°C) for their further test. All samples were analyzed for weight loss, vitamin C, conductivity, microbial count and sensory (colour, flavor and texture) evaluation.

Sample analysis

Sample quality was analyzed by visual observation. Three trained panelist (Haque et al., 2016) were scored the colour, flavor and texture of each sample separately by using 9 point hedonic scale recommended by Baker (1962). Weight loss and vitamin C were estimated through the methods by Ranganna (2003). Conductivity was measured by conductivity meter (Zubehorbox Cond, Germany). Total plate count for bacteria and fungi were estimated by the method used by Ranganna (2003).

Statistical analysis

Results of three replicates were used for statistical analysis. The values were expressed as the mean. Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) (version 21) for Windows. The Duncan test was performed to evaluate the significant differences among mean values. The confidence limits used in this study were based on 95% ($P < 0.05$).

Result and Discussion

Effect of storage conditions on sensory properties of fresh cut.

Changes of sensory parameters during storage at normal temperature (ambient temperature), chilling temperature (3-7°C) and freezing temperature (-18°C) are presented in Table 1, Table 2 and Table 3 respectively.

Table 1. Sensory evaluation of fresh cut cabbage in normal condition concerning different packaging material

Packaging material	Day	Color	Flavor	Texture
25µ	1	8.6	8	9
	2	7.6	7.3	8.6
	3	7.6	6.3	8
	4	7	5	7.3
	5	6.6	4.3	5
50µ	1	9	8.6	8.6
	2	8.6	7.6	8.3
	3	7.6	6.6	7.6
	4	6.6	5.6	6.6
	5	5.6	5	6.3
100µ	1	9	8.3	9
	2	8.6	7.6	8.6
	3	7.6	7.3	7.6
	4	7	6.6	7.3
	5	6.6	4.6	6.6
Foil	1	9	8	8
	2	8.3	7.6	7.3
	3	8	6.6	6.6
	4	7.6	5.6	5.6
	5	4.6	4.3	4.3

Average of three replications

Colour, flavore and texture of stored sample observed by the panelist were deteriorated with storage time. Foil paper as packaging material showed negative effect on fresh cut cabbage. In fifth days of storage at least one of the three members in sensory panel dislike slightly the color or flavor of fresh cut cabbage and the study didn't carry on. It was observed that 100µm packaging material retained well the physical condition of cabbage comparing other packaging materials.

Table 2. Sensory evaluation of fresh cut cabbage in chilling temperature concerning different packaging material

Packaging material	Day	Color	Flavor	Texture
25µ	2	8.6	8.3	8.6
	4	8	7	7.6
	6	7	6.3	6.6
	8	6.6	5.3	6.0
50µ	2	9	8.6	8.6
	4	8	7.3	8
	6	7.3	6.6	7
	8	6.6	6	6.3
100µ	2	8.3	8	8.6
	4	7.6	7	7.6
	6	6.6	5.6	6.6
	8	6	6	6.3
Foil	2	7	7	8
	4	6.6	6	7
	6	6	5.3	6.6
	8	5.6	5	5.6

Average of three replications

In the refrigeration temperature fresh cut cabbage was observed like slightly to dislike slightly after 8 days of storage (Table 2). In this storage condition the fresh cut cabbage became crispy but after released the heat it became fresh. According to Hedonic scale, cabbage stored in chilled condition in 50µm polyethylene material retained of all the physical attributes well comparing to other packaging materials.

At the freezing temperature fresh cut cabbage showed abrupt distortion of its texture and became soft during thawing and therefore, a lot of water leaching out from cabbage. Fresh cut cabbage couldn't retain its body structure. In Hedonic scale, cabbage storage in freezing condition, packaging within foil paper retained of all the physical attributes well comparing to other packaging material (Table 3).

Table 3. Sensory evaluation of fresh cut cabbage in freezing condition concerning different packaging material

Packaging material	Day	Color	Flavor	Texture
25µ	2	7.3	8	7.3
	4	6.6	6.6	6.3
	6	6	6.3	5
	8	5	5.3	4.3
50µ	2	7.6	7.6	7.3
	4	7	6.3	5.6
	6	6.5	5.6	5.3
	8	5.5	4.6	4.6
100µ	2	8.6	8	7.6
	4	7.3	7.3	6.3
	6	6	6	5.3
	8	6.3	5.3	4.6
Foil	2	8.3	8	7.6
	4	7.6	7.3	6.6
	6	6.6	6.3	6.3
	8	6	5.3	5.3

Average of three replications

Weight loses in different storage conditions

Effect of packaging material on weight loss of cabbage fresh cut at ambient storage temperature, chilling temperature and freezing temperature are presented in Figs. 1, 2 and 3, respectively.

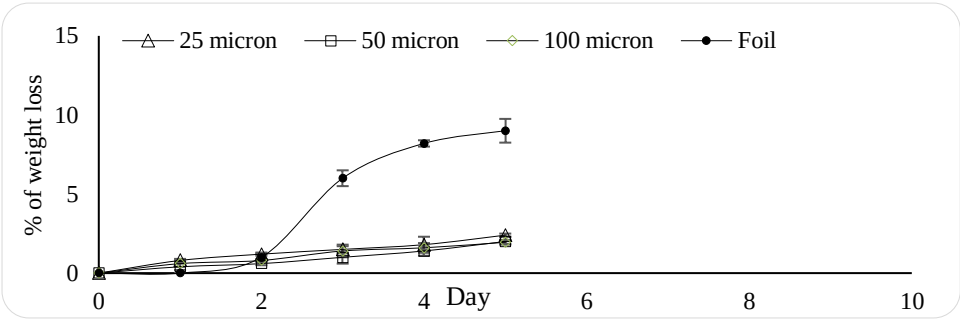

Fig. 1. Comparison of weight loss of fresh cut cabbage storage in different packaging material during storage at ambient temperature

Fig. 1 shows that during storage at ambient temperature foil paper had negative effect on fresh cut cabbage. Higher amount of water lost from cabbage at ambient temperature. Fresh cut cabbage storage in foil paper lost higher amount of water compared other packaging materials. Cabbage stored in foil paper lost higher percentage of water from second day and it continued till last day. About 9 % water had lost from fresh cut cabbage storage in foil paper. Fresh cut cabbage storage in 25 µm polyethylene had lost also 2.4% water and at the same time 50µm polyethylene lost approximately 2% water at fifth day. Among the packaging materials, 100µm polyethylene was found the best to retain water.

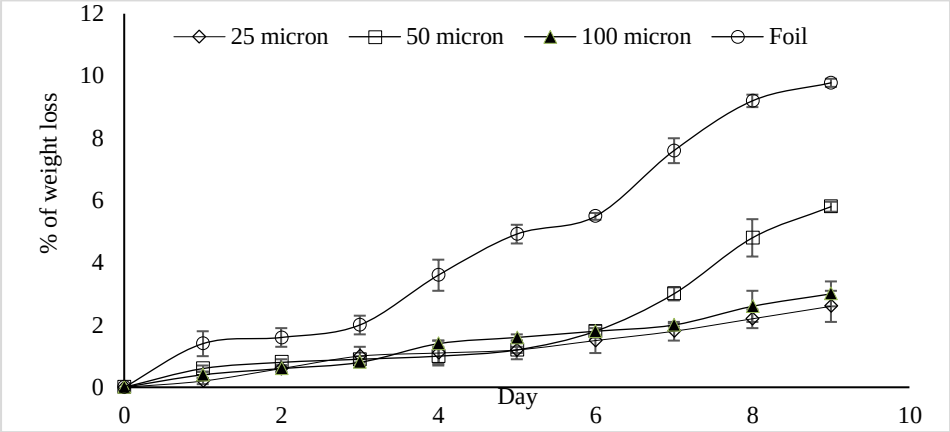

Fig. 2. Comparison of weight loss of fresh cut cabbage storage in different packaging material during storage at refrigeration temperature

Storage at chilling temperature, fresh cut cabbage was found minimum water loss during the storage period. It became crispy but warm up to normal temperature it became fresh and didn't leaching out so much water like freezing condition. Cabbage storage at chilling temperature in 25µm thick polyethylene pack had lost only 2.6% moisture at ninth day. Fresh cut cabbage storage in packaging material 100 µm had lost approximately 3% moisture at the last day of the study. Product storage in foil paper had lost 9.78% moisture at the last day.

Fig. 3 revealed that the highest water loss was observed at freezing storage. This is due to the fresh cut cabbage became frozen at freezing temperature and a lot of water leached out during thawing. Cabbage stored at freezing temperature in 50 µm packet lost about 4.7 % moisture on ninth day. Though small amount of moisture was leached out distortion was the same as that of other cabbage stored at freezing temperature. Cabbage storage in 100 µm polyethene lost approximately 8% moisture at the 9th day of the study. Product storage in foil paper lost 10.8% moisture on 9th day of study. Product storage at 25 µm polethene has lost approximately 6.2% moisture.

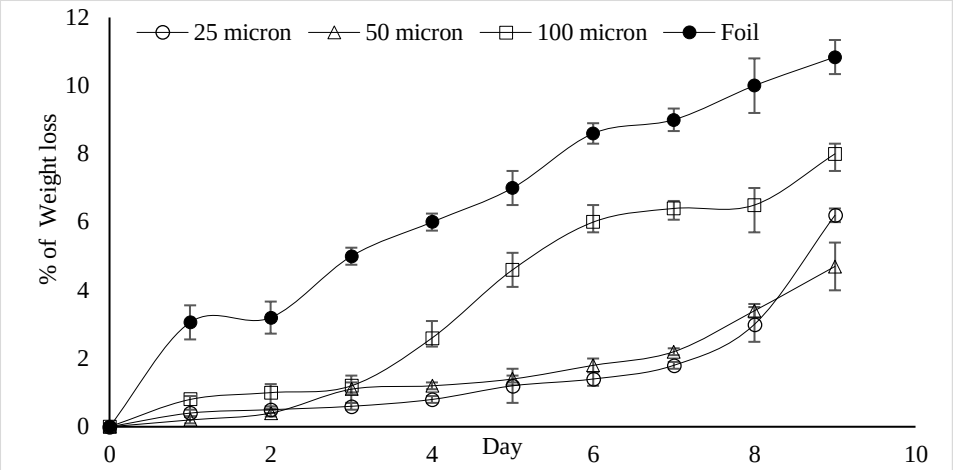

Fig. 3. Comparison of weight loss at freezing condition in different packaging material during storage at freezing temperature

Loss of Vitamin C in different storage conditions

Comparison of vitamin-C loss in different packaging material during storage at ambient temperature, chilling temperature and freezing temperature is presented in Fig. 4, 5 and 6 respectively.

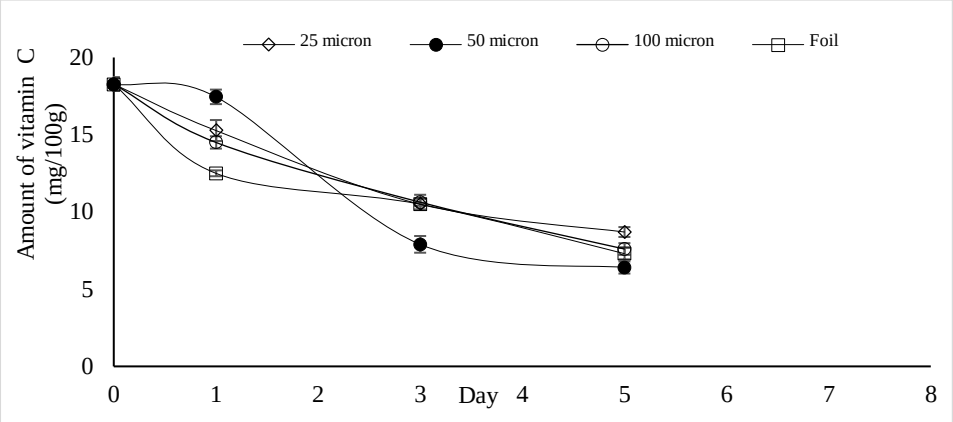

Fig. 4. Loss of vitamin C in fresh cut cabbage at ambient temperature

Amount of vitamin C in fresh cut cabbage was affected by storage condition and packaging material used (Fig. 4). Initially the amount of vitamin C was calculated about 18.27mg/100gm of cabbage. At ambient temperature the vitamin C content decreased at significant level during fifth day of study. Fresh cut cabbage storage at packaging material 25µm retained significant amount of vitamin C about 8.7mg/100gm of cabbage. Packaging material 50µm retained least amount of vitamin C in this condition (6.4 mg/100gm).

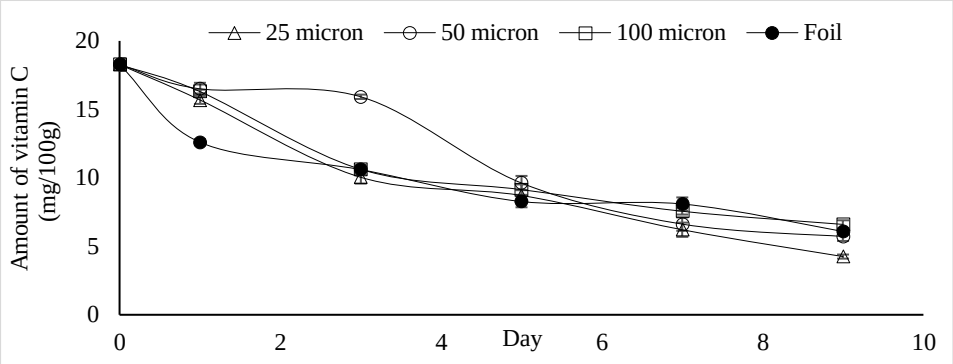

Fig. 5. Comparison of vitamin-C loss in different packaging material during storage at chilling temperature

Cabbage storage at chilling temperature in 25 µm polyethylene pack had lost only 2.6% moisture on ninth day. However, it retained 4.25 mg vitamin C presented in Fig. 5. Fresh cut cabbage stored 100 µm polyethylene pack could retained 6.6 mg vitamin C at the last day of the study. Product storage in foil paper retained 6.08 mg vitamin C on the ninth days of study.

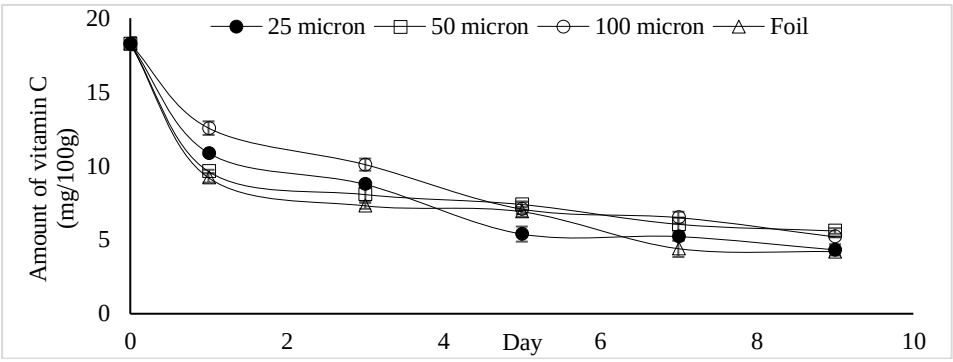

Fig. 6. Comparison of vitamin-C loss of fresh cut cabbage storage in different packaging material at freezing temperature

Cabbage storage at freezing temperature in foil package was found to contain least vitamin C (4.2 mg/100g) followed by 25µm polyethylene which retained 4.32 mg/100g. Cabbage stored in 100 µm polyethylene was found to retain the highest amount of vitamin C at the 9th day of study. Generally, during storage in different packaging material and storage temperature vitamin C was deceased with storage time. The results of the present study agreed with earlier works. Previous research reported that the storage condition has significant effect on the loss of vitamin C (Leonardi et al., 2001).

Conductivity in different conditions

Effect of packaging material on conductivity of fresh cut cabbage at ambient, chilling and freezing temperature is presented in Fig. 7, 8 and 9 respectively. Conductivity indicates

the amount of ions present in fresh cut cabbage which is correlated with cell rapture. At ambient temperature 100 micron polyethylene and foil packet showed the highest and the lowest conductivity, respectively in fifth day of storage (Fig. 7). Fresh cut cabbage stored in foil paper lost higher amount of water compared with other packaging materials and therefore, exhibited lowest reading in conductivity meter (3.10 ms/cm). Cabbage stored in foil paper lost higher percentage of water from first day of storage and it continued till last day and conductivity was the lowest among the sample studded. In this case fresh cut cabbage stored in 100 µm gave higher reading in conductivity meter that meant the product reserved higher amount of electrolytes.

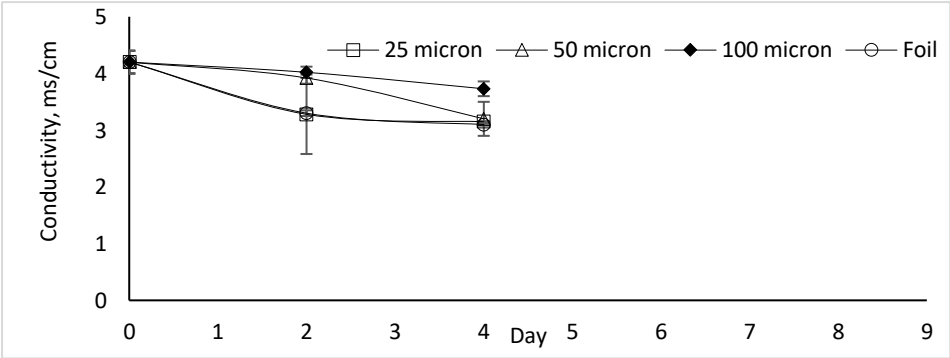

Fig. 7. Comparison of conductivity of fresh cut cabbage stored in different packaging materials at ambient temperature

In chilling storage condition, conductivity of fresh cut cabbage sample reduced rapidly after 4th day of storage. Initial day the conductivity of cabbage was 4.2 ms/cm and reduced to 3.13 ms/cm during 9th day of storage. Among the packaging material used, foil paper showed the lowest (3.13 ms/cm) and 50 µm pack showed the highest reading in conductivity meter (3.4 ms/cm) which indicated that the product reserved the lowest and the highest amount of electrolytes, respectively. Cabbage stored at 25 µm and 100 µm polyethylene pack showed conductivity approximately 3.31 ms/cm and 3.3 ms/cm, respectively.

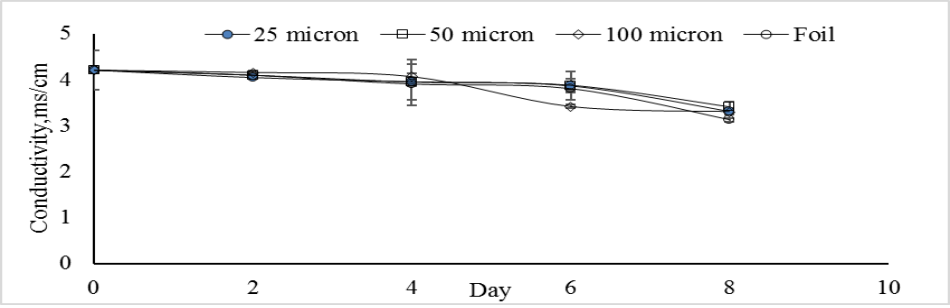

Fig. 8. Comparison of conductivity of fresh cut cabbage stored in different packaging material at chilling temperature

In freezing condition conductivity of fresh cut cabbage in all packaging material studied reduced during storage time. In this case fresh cut cabbage stored in 50 µm showed higher reading of conductivity (3.2 ms/cm) which indicated that the product reserved higher amount of electrolytes till the last day of study. Cabbage stored in 100 µm and 25 µm polyethylene packet showed reading 3.10 (ms/cm) and 3.02 (ms/cm) in conductivity meter. During freezing condition of storage cabbage became fragile and hence cell rupture occurred. In this temperature of storage cabbage lost water during thawing and the same time electrolytes also leaching out day by day. Fresh cut cabbage stored in foil paper lost higher amount of water comparing other packaging material. Though the conductivity of fresh cut cabbage storage in foil paper gave the lowest reading of conductivity meter approximately 2.85 ms/cm.

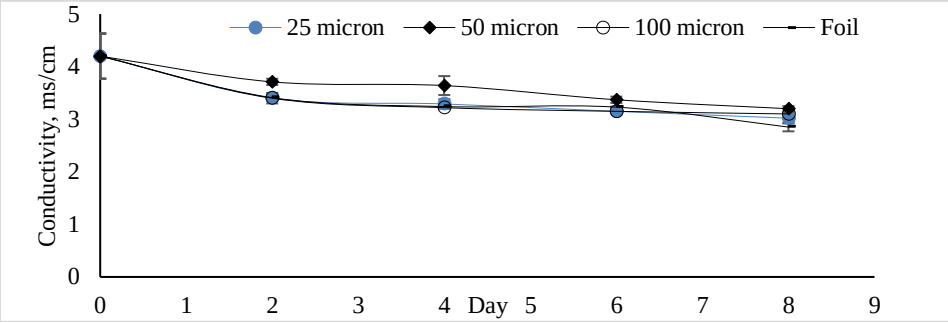

Fig. 9. Comparison of conductivity of fresh cut cabbage stored in different packaging material at freezing temperature

Bacterial growth in different conditions

In the study of bacterial growth of fresh cut cabbage stored at ambient, chilling and freezing temperature in different packaging material is presented in Fig. 10, 11 and 12. Fig. 10 showed that at ambient temperature foil paper provided most favorable condition for bacterial growth.

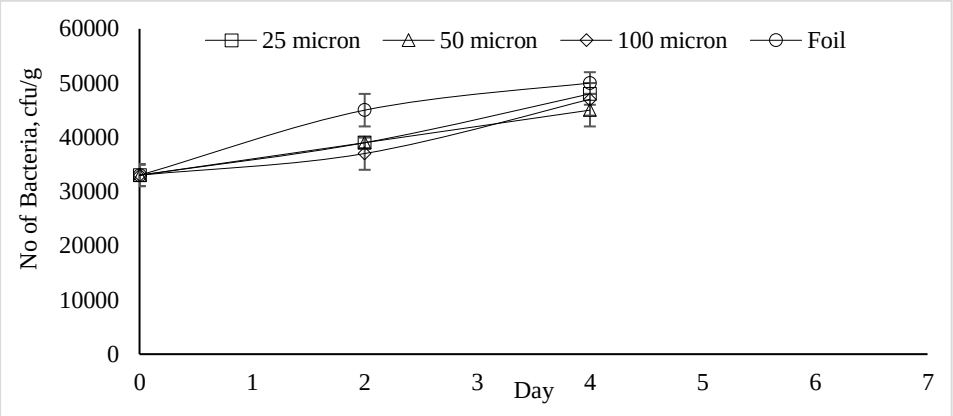

Fig. 10. Bacterial growth count during normal condition concerning different packaging material

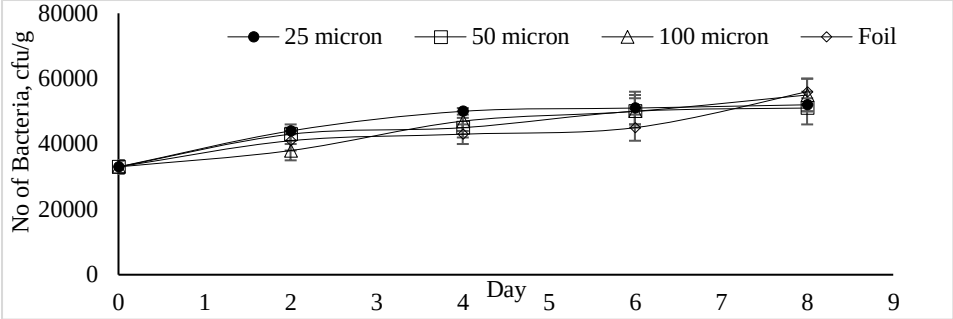

Fig. 11. Comparison of bacterial growth in chilling condition concerning different packaging material

Cabbage stored in foil paper lost higher percentage of water from first day of storage and it continued till last day and bacterial growth increased simultaneously. At the initial day the number of bacteria found about 33000 cfu/g and the fifth day the microorganism increase to about 50000 cfu/g in foil paper. Minimum bacterial count was observed in 100 µm followed by 50 µm packet.

During chilling storage bacterial count increased with storage time for all packaging materials studied. Among the packaging materials the highest bacterial colony was found in foil packet which indicated that the foil paper provided most favorable condition for bacterial growth. At the initial day the number of bacteria colony found about 33000 cfu/g and the ninth day the number was about 56000 cfu/g in foil paper. At the same storage temperature cabbage stored in 25 µm, 50 µm and 100 µm polyethylene pack had the number of bacteria about 52000, 51000 and 55000 cfu/g respectively. Fresh cut cabbage storage in foil paper lost higher amount of water compared other packaging materials and bacteria got enough moisture to grow.

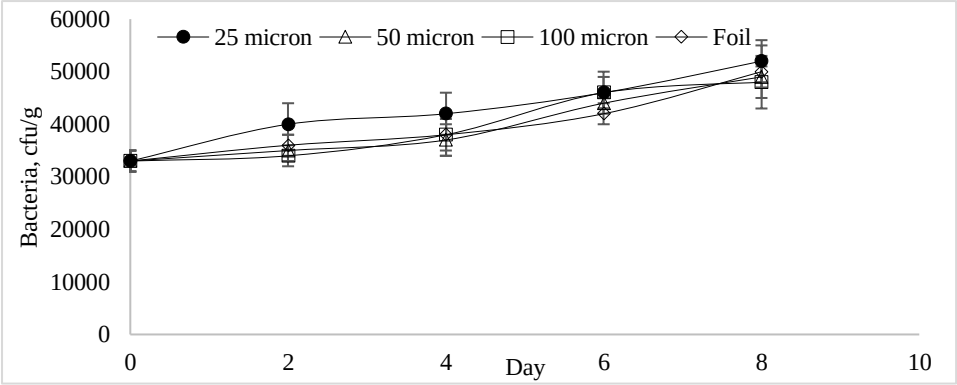

Fig. 12. Comparison of bacterial growth in freezing condition concerning different packaging materials

At the initial day the number of bacteria found about 33000 cfu/g and at the ninth days of freezing storage it was about 50000 cfu/g in foil paper. At the same time cabbage stored

in polyethylene 25 µm, 50 µm and 100 µm had the number of bacteria about 52000, 49000 and 48000 cfu/g respectively at this condition (Fig. 12). As freezing temperature didn't provide favorable condition for mesophilic bacteria and though bacterial growth was minimum.

Fungal growth in different condition

Fig. 13, 14, 15 represent the effect of packaging material on fungal growth in fresh cut cabbage stored in ambient, chilling and freezing temperature, respectively. Number of fungal colony increased with the storage time for all packaging material and storage temperature. At the initial day the number of fungi found about 32000 cfu/g. Among three storage temperature highest fungal growth was found at ambient temperature (48000 cfu/g) and lowest (35000 cfu/g) at freezing temperature after 4th day of storage. Among the packaging material used foil pack showed the highest fungal growth for all storage conditions and 100 micron polyethylene pack showed the lowest growth.

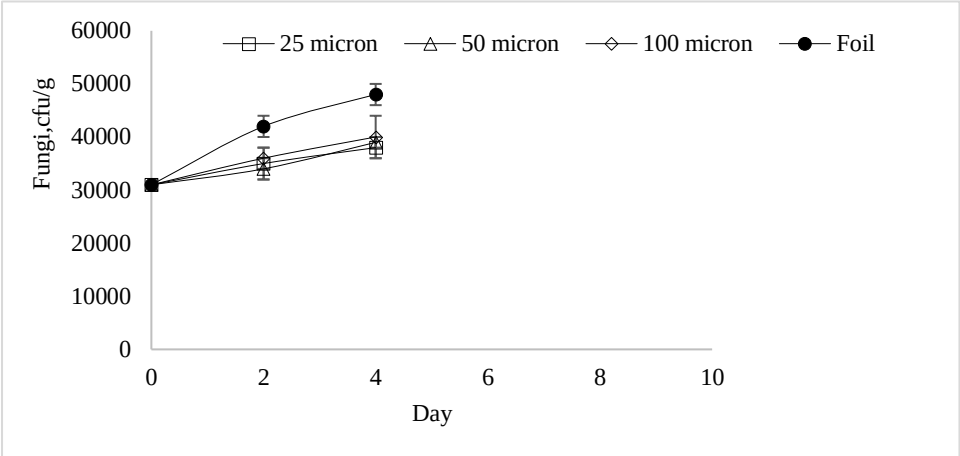

Fig. 13. Comparison the fungal growth during normal condition concerning different packaging materials

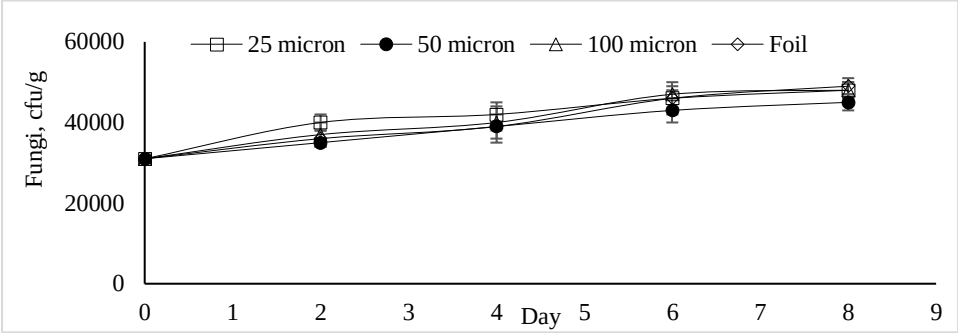

Fig. 14. Comparison of fungal growth in chilling condition concerning different packaging materials

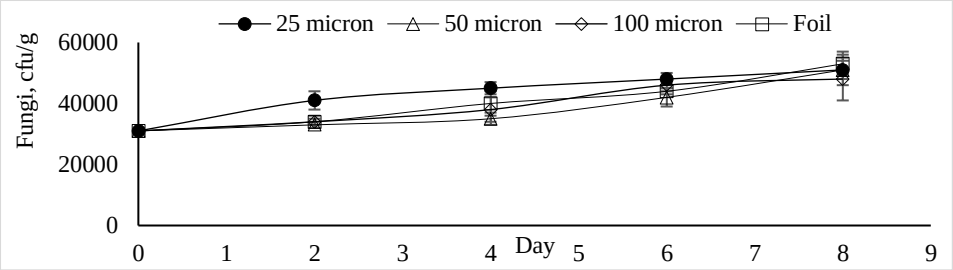

Fig. 15. Comparison of fungal growth in freezing condition concerning different packaging materials

Conclusion

The freshness and safety of fresh cut cabbage extensively depend on packaging material and the temperature at which it was stored. During storage total weight loss was increased and at the same time vitamin C content and conductivity was decreased. Physical changes of fresh cut cabbage such as color, flavor and texture was also observed with storage time. Packaging materials such as polyethylene 100µm and 50µm could protect all the physical appearance of cabbage in chilling condition. Bacterial and fungal growth remained minimum at freezing condition and at the same time chilling temperature retained all the quality better than other conditions. Cabbage stored at foil paper produced off odor during storage at normal temperature.

References

Allahvaisi, S., A.A. Pourmirza and M.H. Safaraliza de. 2009. Packaging of Agricultural Products for Preventing Tobacco Beetles Contaminations. Notul. B. Horti Agrobo. Cluj-N. **37**(2): 218-222.

Baker, R.A. 1962. Subjective panel testing. Ind. Quality control **19**(3): 22-28.

Haque, M.A., R. Begum, S. Akter, I. Uddin and M. M. Sultana. 2016. Performance of Irradiated chitosan and formalin to preserve banana and bitter gourd. Journal of Science and Technology. **6**(1 &2): 161-175.

Highland, H.A. 1981. Resistant barriers for stored- product insects. In: CRC Handbook of transportation and marketing in agriculture. Vol. 1: Food commodities, 41-45, ISSN 0817-8038.

Jenny, M.N.H., C. Sarker, M.A.R. Mazumder and M.F.H. Shikder. 2008. Effect of storage conditions on quality and shelf life of selected winter vegetables. J. Bangladesh Agril. Univ. **6**(2): 391-400.

King, A.D. and H.R. Bolin. 1989. Physiological and microbiological storage stability of minimally processed fruits and vegetables. Food Technol., **43**: 132-135, 139.

Leonardi, C., P. Ambrosino, F. Esposito and V. Fogliano. 2001. Anitioxidant activity and carotenoid and tomatine contents in different typologies of fresh consumption tomatoes. J. Agric. And Food Chem. 48: 4723-4727.

Ranganna, S. 2003. Hand Book of Analysis and Quality Control for Fruit and Vegetable Products.2nd Edition. McGraw Hill Education (India) Private Limited, New Delhi. pp. 12-26.

Robert, E.P. 1999. Effect of temperature and relative humidity on fresh commodity quality. Postharvest Biology and Technology. **15**(3): 263-277.