Effect of different packaging materials and modified atmospheric packaging on enhancing the shelf life of Palak and coriander under different storage conditions

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ABSTRACT

The green leafy vegetables are rich in vitamins and minerals. They are highly perishable in nature this may be due to increased rates of respiration and transpiration. Method of packing and packaging materials has greater influence on extending the shelf life of the produce. Based on this, research was carried out to increase the shelf life of two major leafy vegetables *viz.,*Palak (*Beta vulgaris L. var. bengalensis*) and Coriander (*Coriandrum sativum* L.) using Modified Atmospheric Packaging (MAP) as well as different packaging materials. The research was carried using FCRD experimental design with 12 treatments stored under ambient and refrigerated conditions. Three different gas compositions along with two different packaging materials were employed .The produce remains fresh for about 4 days under ambient storage and for about 15 days under refrigerated storage. Under Ambient conditions, for Palak better shelf life was observed in T_3 - G_3M_1(4% O_2, 5% CO_2, ~~91% N_2~~, LDPE) followed by T_5 - G_2M_2(6% O_2, 5% Co_2, ~~89%N_2~~, PP) whereas for coriander better shelf life was observed in T_2 – G_2M_1 (6% O_2, 5% CO_2, ~~89% N_2~~, LDPE) followed by T_6 – G_3M_2 (4% O_2, 5% CO_2, ~~91% N_2~~, PP) ~~was best~~. Under refrigerated storage conditions, for Palak better shelf life was observed in T_9 - G_3M_1(4% O_2, 5% CO_2, ~~91% N_2~~, LDPE) followed by T_{12} - G_3M_2(4% O_2, 5% CO_2, ~~91% N_2~~, PP) whereas for coriander it was observed that T_{12} - G_3M_2 (4% O_2, 5% CO_2, ~~91% N_2~~, PP) followed by T_8 - G_2M_1(6% O_2, 5% CO_2, ~~89% N_2~~, LDPE) was proven best for extending the shelf life. Therefore , the refrigerated produce showed higher shelf life when compared to the produce that are stored under ambient conditions.

Comment [CC2]: Improve the english; Improve description of the methods. Should be clear the Study Design, Place and Duration of Study, Methodology, Results, Conclusions.

Keywords: Ambient, Refrigerated, Modified atmospheric packaging (MAP), Green leafy vegetables and Shelf life

1. INTRODUCTION

In recent times due to increased health consciousness, leafy greens have gained popularity. These leafy green vegetables are the richest source of calcium and usually low in fat, high in dietary fibre, rich in folic acid, C-vitamin, potassium, and magnesium. These leaves lose their marketability after the harvest because they senesce quickly and have a higher rate of respiration and transpiration. However, because

of inappropriate handling techniques, increased water activity, and high rates of respiration, they suffer greatly in terms of post-harvest losses.

Palak (*Beta vulgaris L. var. bengalensis*) is a leafy vegetable that can be eaten in a variety of ways, like fresh, frozen, preserved, chopped, dehydrated, or cooked. It's packed with nutrients, like vitamin A, vitamin C, and potassium, as well as magnesium and manganese. It is also packed with riboflavin and vitamin E, as well as calcium and potassium. It's a great source of dietary fibre, choline, and inositol - all of which help to prevent artery hardening (arteriosclerosis).

Coriander (*Coriandrum sativum* L.) is one of the most widely used spices in the world, providing flavour and aroma to a variety of foods. It has long prehistory of being used in folk medicine in different civilizations [1].It's high in lipid (petroselinic acid) and essential oil (0.03-2.6%) linalool. It can be found in seeds and aerial parts, and has a range of pharmacological properties, including anti-oxidants, antibiotics, anti-diabetes, antiepileptic, anti-mutagenic, anti-depressants, anti-anxiety, anti-high blood pressure, anti-inflammation, neuroprotective, diuretics.

One of the packaging techniques for enclosing the food and extending the storage life is modified atmosphere packaging (MAP), which has a composition different from that of ambient air. It lowers the fresh product's respiration rate and generally increases shelf life [2]. Produce is protected by packaging, which also has a significant impact on how air moves about the item. This affects how to maintain the relative humidity as well as the temperature of produce throughout storage and transportation. MAP is demonstrated to be a reliable replacement for the costly CA storage and an effective way for preserving food with high quality and nutritional content[8]. As a result, MAP making use of various packing materials offers the possibility of extending postharvest life. Minimum PLW was observed in coriander packed in MAP without perforation [7]. Vegetables shelf life may be increased by altering the composition of the gases around them and storing them cold afterward. In order to maintain a longer shelf life without lowering the quality of the food during storage, it is desirable to use a combination of control environment and low temperature. [3]. The weight loss, colour value, chlorophyll content, and beta carotene content of coriander leaves did not significantly change after 20 days [4]. Therefore, the goal of the current study was to increase the shelf life of coriander and palak by using different packaging materials as well as different gas compositions, preserving the quality.

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2. MATERIALS AND METHODS

2.1 SAMPLE PREPARATION

This experiment was conducted at the Department of Vegetable Science as well as in the laboratory of Department of Food processing and engineering, Tamil Nadu Agricultural University, Coimbatore. Plant samples were collected from the research fields of TNAU. Freshly harvested Palak (variety : All green) and Coriander (variety : CO-5) with consistent size, and matured state were used. To get rid of sick and

uneven leaves, sorting and grading was carried out manually[6]. Prior to packaging, the samples were washed with ~~clean~~ potablewater and surface dried by placing them in the shade for 15 minutes [10] in order to eliminate all the impurities. A sample of 250 grams was weighed carefully and taken individually for each treatment for both the crops.

Comment [CC4]: Add the model, brand and units with sensibility (for example (0,001g) of measure of the weight scale

2.2DESIGN & LAYOUT OF THE EXPERIMENT

The design of the experiment was FCRD (Factorial completely randomized block design) with 12 different treatments for both the crops (Palak and Coriander). Three different gas compositions i.e., G1 (5% O2, 5% CO2, 90% N2) , G2 (6% O2, 5% CO2, 89% N2) and G3 (4% O2, 5% CO2, 91% N2) , two different packaging materials LDPE (low density poly ethylene) and PP (polypropylene) covers measuring 10 ×12 inch and thickness of around 100 microns were used.

Table 1 : Table showing the treatments details of the experiment

Treatment	Storage environment	Gas Composition (O_2: Co_2: N_2)	Packaging material
T1 – $R_1G_1M_1$	Ambient	5% O_2, 5% C~~O~~o_2, 90%N_2	LDPE
T2 – $R_1G_2M_1$	Ambient	6% O_2, 5% Co_2, 89%N_2	LDPE
T3 – $R_1G_3M_1$	Ambient	4% O_2, 5% Co_2, 91%N_2	LDPE
T4 – R_1G1M_2	Ambient	5% O_2, 5% Co_2, 90%N_2	PP
T5 – $R_1G_2M_2$	Ambient	6% O_2, 5% Co_2, 89%N_2	PP
T6 – $R_1G_3M_2$	Ambient	4% O_2, 5% Co_2, 91%N_2	PP
T7 – $R_2G_1M_1$	Refrigerated	5% O_2, 5% Co_2, 90%N_2	LDPE
T8 – $R_2G_2M_1$	Refrigerated	6% O_2, 5% Co_2, 89%N_2	LDPE
T9 – $R_2G_3M_1$	Refrigerated	4% O_2, 5% Co_2, 91%N_2	LDPE
T10 – $R_2G_1M_2$	Refrigerated	5% O_2, 5% Co_2, 90%N_2	PP
T11 – $R_2G_2M_2$	Refrigerated	6% O_2, 5% Co_2, 89%N_2	PP
T12 – $R_2G_3M_2$	Refrigerated	4% O_2, 5% Co_2, 91%N_2	PP

Here, R – Storage environment, G – Gas composition, M – Packaging material

2.3STORAGE ENVIRONMENT

2.3.1 Ambient Storage (R_1) :

Palak and Coriander were packed in different materials and maintained at room temperature in the Food Processing laboratory for storage. The Relative Humidity (RH) ranged from 55% to 65% and the average temperature was 35±5°C.

2.3.1 Cold Storage (R_2) :

Palak and coriander were kept in cold storage for a predefined period of time -16 days at a temperature of 5°c and 90% relative humidity.

SHELF LIFE? WHAT IS IT AND HOW WAS DETERMINE?
HOW YOU TAKE THE SAMPLES DURING THE STUDY? HOW MUCH SAMPLES AND IN WHAT DAYS?

2.4 PHYSIOLOGICAL LOSS IN WEIGHT (PLW)

To assess physiological loss in weight, the sample was precisely weighed at the beginning of the experiment and then on each subsequent day. The physiological loss in weight (PLW) was calculated by deducting the final weight from the initial weight of the samples, dividing by the initial weight, and then expressing the value in percentage [11].

$$\% \text{ PLW} = \frac{\text{Initial wt.(g)} - \text{Final wt.(g)}}{\text{Initial wt.(g)}} \times 100$$

2.5 STATISTICAL ANALYSIS

~~The commonly used Microsoft Excel software was used to analyse the acquired data.~~ Furthermore, a thorough analysis of the collected data was carried out using the ~~well-known~~ statistical programmes OP stat and Grapes KAU. ~~The investigation was specifically concerned with determining the degree of Physiological Loss in Weight (PLW) seen in the green leafy vegetables under various treatment conditions.~~ Analysis of Variance (ANOVA), ~~a commonly used statistical method~~, was ~~carefully~~ used to identify statistically significant changes across the treatment groups ~~in order to determine the significance of observed differences~~.

3. RESULTS AND DISCUSSION

Comment [CC5]: Add the equipment and the caracteristics to measure the PLW. This was the only parameter study??

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The change in sample weight over the course of storage was used to calculate the amount of water lost from the fresh leaves. The analysis revealed the difference in physiological weight loss (%) that was seen. The influence of packaging materials and gas composition on the PLW (%) of Palak & Coriander stored under ambient as well as cold environments was evident in the ANOVA table, and was found to be statistically significant at the 0.1% level of significance. Regardless of the original composition of the atmosphere, oxygen level will rapidly decline in Palak leaves packed in different packaging materials [9].On the third day of storage, all samples in treatments other than T2 and T6 were spoiled in case of Coriander. whereas in Palak, all samples other than T3 and T5 were spoiled after three days of storage in ambient environments. While under cold conditions, samples T1 and T3 spoiled on the 13th day of storage, sample T4 spoiled on the 14th day of storage, and samples from all other treatments spoiled after the 15th day in the case of coriander. However, samples T1 and T5 began to spoil on the 14th day of storage in case of Palak.

Table 2. Physiological loss of weight(%) of Palak and Coriander under different treatments

Treatment	Palak				Coriander			
T1	1.20				1.84			
T2	1.08				1.41			
T3	0.64				2.01			
T4	1.32				2.23			
T5	0.85				2.45			
T6	0.93				1.67			
T7	0.57				1.20			
T8	0.65				0.38			
T9	0.17				0.62			
T10	0.74				0.46			
T11	0.52				0.41			
T12	0.31				0.30			
	R	**G**	**M**	**RGM**	**R**	**G**	**M**	**RGM**
S. Ed	0.006	0.007	0.006	0.014	0.007	0.008	0.007	0.017
CD	0.012***	0.014 ***	0.012***	0.029***	0.014***	0.017***	NS	0.034***

Here, R – Storage environment, G – Gas composition, M – Packaging material

*** *Significance at 0.001 level*

3.1 Effect of packaging materials and gas composition on PLW (%) of Palak stored at ambient conditions

The weight loss during storage ranged from 0.6% to 1.32%. From the Figure 1, it was clear that treatment T3 resulted in the smallest amount of weight loss followed by T5. When compared to samples packed in PP , LDPE bags showed the least physiological weight loss during the course of a three-day storage period. It might be because LDPE bags transmit water vapour at a lower rate than any other packaging materials [12]. Fresh vegetables that have lost water may become less turbid, lose nutritional value, or change colour in an unfavorable way.

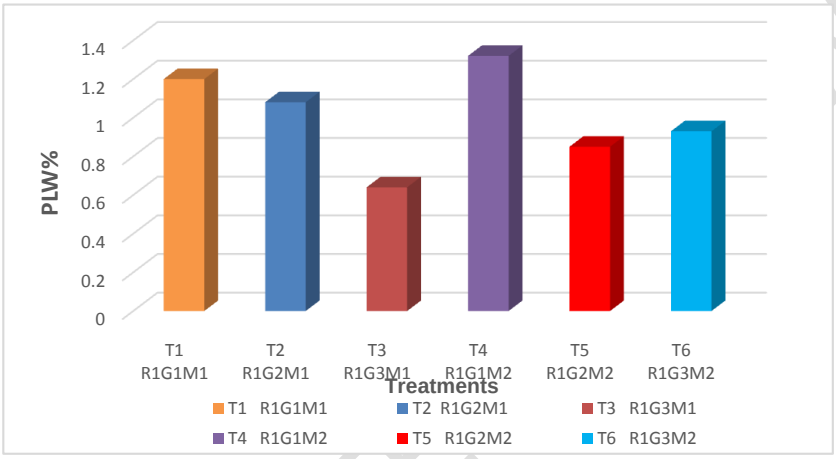

Fig. 1.Physiological loss in weight for various treatments in Palak under ambient conditions

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3.2Effect of packaging materials and gas composition on PLW (%) of Coriander stored at ambient conditions

A weight loss of 1.4 % to 2.4 % occurred during storage. It was evident from Figure 2 that Treatment T2 caused the least amount of weight reduction, followed by Treatment T6 . LDPE bags exhibited the least physiological weight loss followed by PP bags. Respiration and transpiration of the produce in storage are the main causes of the weight loss [13].

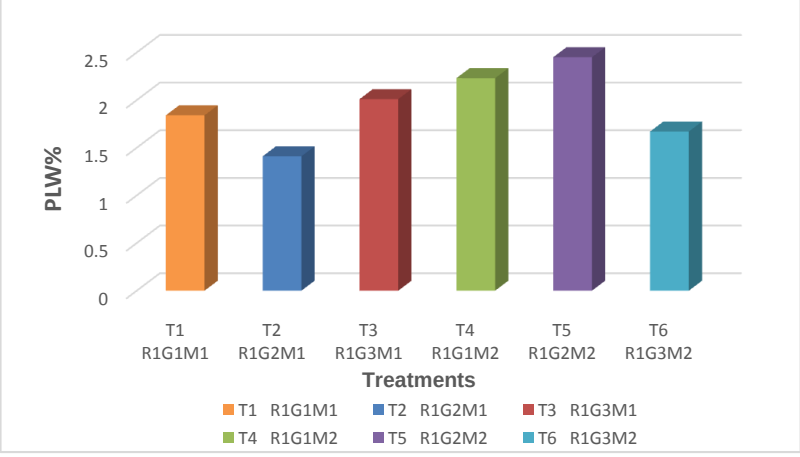

Fig.2.Physiological loss in weight for various treatments in Coriander under ambient conditions

3.3Effect of packaging materials and Gas composition on PLW (%) of Palak stored at Refrigerated conditions

Over the course of storage, weight loss varied from 0.17% to 0.74%. Figure 3 shows that minimal loss of weight is recorded in T9 followed by T12 and LDPE bags were found better compared to PP. Mostly the weight loss was caused by respiration and transpiration [13].T10treatment showed the highest percentage weight loss .The produce stored in a cold atmosphere at 5°C showed a slight (%) weight loss after 14 days.

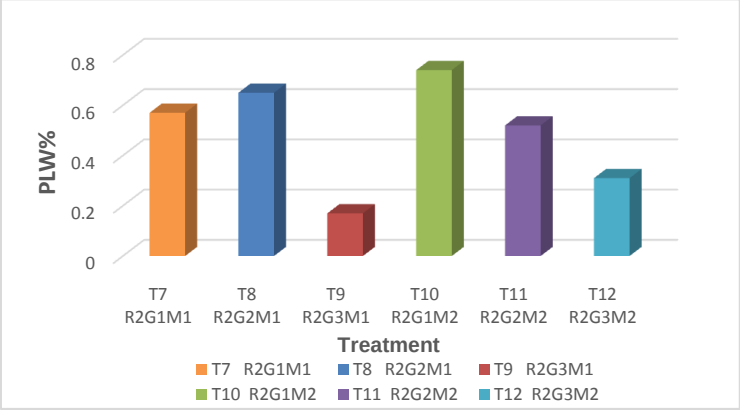

Fig.3.Physiological loss in weight for various treatments in Palak under refrigerated conditions

3.4Effect of packaging materials and Gas composition on PLW (%) of Coriander stored at Refrigerated conditions

Coriander can be kept in the refrigerator for up to 12 days with little PLW, shrinkage, rotting, colour loss, and optimum freshness, earning the consumer preference [5]. Weight loss ranged from 0.3% to 1.2% over the period of storage. As per Figure 4, T12 and T8 noticed minimal weight loss, and PP bags performed better than LDPE. The T7 treatment resulted in the highest percentage weight loss. In the case of produce packed in LDPE, leaf yellowing was also observed after 11 days.

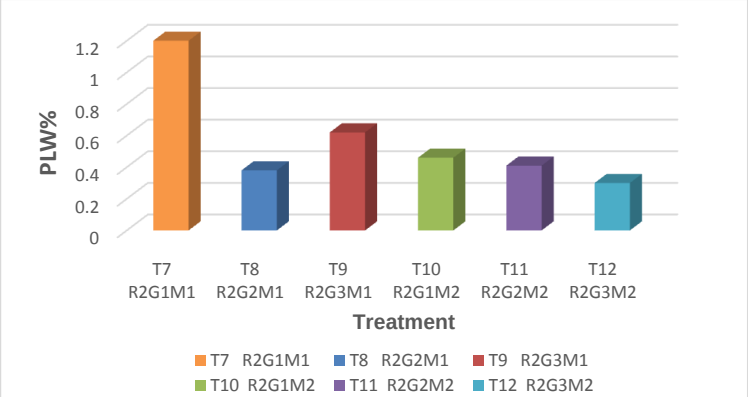

Fig.4.Physiological loss in weight for various treatments in Coriander under refrigerated conditions

P_1P_2

Fig.5.Palak stored under refrigerated conditions at 16th day (P_1– packed in LDPE material and P_2– packed in PP material)

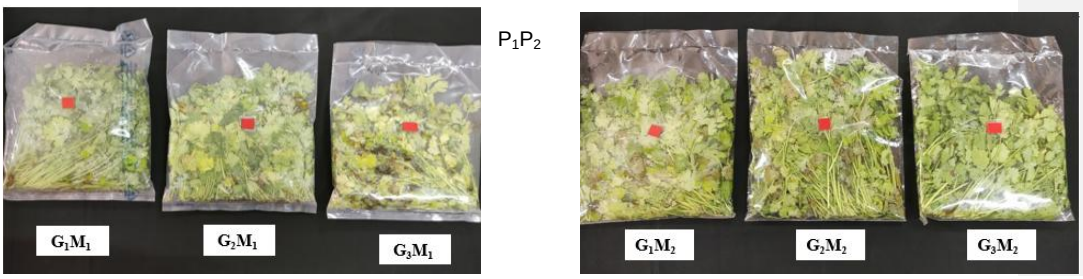

Fig.6.Coriander stored under refrigerated conditions at 16th day (P_1– packed in LDPE material and P_2– packed in PP material)

4. CONCLUSION

Palak packed in LDPE covers had a minimal amount of physiological weight loss (%), followed by PP in both the storage environments. LDPE proved to be the ideal material for packaging. The gas composition G3 (4% O2, 5% CO2, 91% N2) was found best among other gas compositions. The highest shelf life of Palak was found to be 3 and 14 days when kept in LDPE covers at room temperature and refrigerated storage conditions respectively.

In Coriander, under ambient conditions, the minimal PLW (%) was recorded in the produce packed in LDPE with gas composition G2 (6% O2, 5% Co2, 89%N2) followed by the produce packed in PP covers with G3 (4% O2, 5% CO2, 91% N2). Whereas in case of refrigerated conditions, it is PP with G3 followed by LDPE with G2 are found superior.

REFERENCES

Comment [CC8]: Try to put most updated references. search

[1]Sahib NG, Anwar F, Gilani AH, Hamid AA, Saari N, Alkharfy KM. Coriander (Coriandrum sativum L.): A potential source of high-value components for functional foods and nutraceuticals-A review. Phytotherapy Research. 2013 Oct;27(10):1439-56.

[2]Caleb OJ, Opara UL, Witthuhn CR. Modified atmosphere packaging of pomegranate fruit and arils: a review. Food and bioprocess technology. 2012 Jan;5:15-30.

[3]Mudau AR, Soundy P, Araya HT, Mudau FN. Influence of modified atmosphere packaging on postharvest quality of baby spinach (Spinacia oleracea L.) leaves. HortScience. 2018 Feb 1;53(2):224-30.

[4]Pragalyaashree MM, Thirupathi V, Kasthuri R, Rajkumar P. Enhancing Shelf Life of Coriander Leaves by Modified Atmospheric Packaging. Madras Agricultural Journal. 2013 Jun 1;100(apr-jun):1.

[5]Sharangi AB, Guha S, Chakrabarty I. Effect of different packaging materials on storage life of fresh coriander (Coriandrum sativum L) leaves. Nat Sci. 2015;13:100-8.

[6]Kakade A, More P, Jadhav S, Bhosle V. Shelf life extension of fresh-cut spinach. International Journal of Agriculture, Environment and Biotechnology. 2015;8(3):609-14.

[7] Panta R, Khanal A. Effect of Modified Atmospheric Packaging on Postharvest Storage Life of Cilantro (Coriandrum sativum L.) Stored Under Different Conditions. J Hortic. 2018;5(243):2376-0354.

[8] Rai DR, Oberoi HS, Baboo B. Modified atmosphere packaging and its effect on quality and shelf life of fruits and vegetables: An overview. Journal of food science and technology (Mysore). 2002;39(3):199-207.

[9] Bieganska-Marecik R, Radziejewska-Kubzdela E, Czapski J. Application of modified atmosphere packaging to extend shelf-life of minimally processed spinach. Polish Journal of Food and Nutrition Sciences. 2007;57(4 [A]):13-7.

[10] Kaur R, Alam MS, Prasad C, Kumar M. EFFECT OF STORAGE PRE-TREATMENTS ON SHELF LIFE OF FRESH CORIANDER (Coriandrum sativum L.)Agric Res J*, 57 (3)* , pp. 438-443

[11] Koraddi V, Devendrappa S. Analysis of physiological loss of weight of vegetables under refrigerated conditions. International Journal of Farm Sciences. 2011;1(1):61-8.

[12] Piagentini AM, Güemes DR. Shelf life of fresh-cut spinach as affected by chemical treatment and type of packaging film. Brazilian Journal of Chemical Engineering. 2002;19:383-9.

[13] Nagar V, Hajare SN, Saroj SD, Bandekar JR. Radiation processing of minimally processed sprouts (dew gram and chick pea): effect on sensory, nutritional and microbiological quality. International journal of food science & technology. 2012 Mar;47(3):620-6.

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