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Full Length Research Paper

Use of modified atmosphere on packaging cut flower gladiolus *Gladiolus grandiflorus* Hort

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The effect of use of modified atmosphere packaging technology (MAP) for increased shelf life of the Cut spikes of gladiolus *grandiflorus* Hort were studied. Three mixtures gas were evaluated, in two temperature conditions. The best condition was in the mixture with 70% N_2, 15% CO_2, 15% O_2. Modified atmosphere packaging allowed conservation of cut spikes gladiolus by six days in polyethylene bag median barrier a 5°C. The cut flowers had six days in vase life after of stored in modified atmosphere packaging (MAP).

Key word: Gladiolus, modified atmosphere packaging.

INTRODUCTION

The genus Gladiolus comprises 260 species, 250 of which are native to sub-Saharan Africa, mostly South Africa. The impressive flower spikes of Gladioli come in a wide array of beautiful colors. Gladiolus is an important bulbous ornamental plant that occupies a prime position among commercial flower crops, which has demand in both domestic and international market. It occupies eighth position in the world cut flower trade.

Modified atmosphere package (MAP) improves product quality and consequently reduces possible biochemical changes (Gvozdenovic et al., 2006; Achour, 2005; Shen et al., 2006). MAP is a technology that has not been widely applied in ornamental species. However several MAP treatments have demonstrated their ability to extend the postharvest life of cut flowers like anthurium, carnation, tulips and lilys (Luo et al., 2004). MAP is effective to maintain quality through its effects on the modification of the gas composition in the package (Al-Ati and Hotchkiss, 2002; Mir and Beaudry, 2004). Several factors affect the final atmosphere packaging including temperature and product weight (Bell, 1996).

When the MAPs are used the gases are removed or added to create an atmosphere around the product composition that is different from that of air (78.08% nitrogen, 20.95% oxygen and 0.03% carbon dioxide), generally, reducing the concentration of oxygen or carbon dioxide increases. According to Kader (2002) the beneficial effects of the MAPs include: delay senescence associated physiological and biochemical changes such as reduction in the rate of respiration rate of ethylene

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production, softening, reduced sensitivity to ethylene which gives lower levels of 8% oxygen and carbon dioxide above 1%, relief of certain physiological disorders and chilling injury, MAPs affect pathogens postharvest and therefore decreases the presence of rot. Increased levels of carbon dioxide 10 to 15% inhibit the growth of some fungi.

It is generally recommended that the cut flowers must be maintained at temperatures not higher than 2°C; however the present study was undertaken to investigate the effect of MAP in shelf life with the use of two temperatures.

MATERIALS AND METHODS

Plant material and preparation

All spikes were harvested in tight bud stage and 120 cm length stem were collected in fields de Yuatepec Morelos México, the harvest took place from 7 to 8 a.m. Spikes were sorted by appearance, diseased, damaged, were discarded, and the spikes stems were trimmed by hand to a length of 15 cm. Five spikes were placed in polyethylene bag of 33.02 cm × 45.72 cm, median barrier Cryovac ME-300.

Modified atmosphere packaging (MAP) in gladiolus

To determine and select appropriate gas conditions and the temperature in the storage were according to a 3 × 2 factorial design. Three gas mixtures were evaluated: (1) 90% N_2, 10% CO_2; (2) 90% N2, 5% O_2, 5% CO_2; (3) 70% N_2, 15% CO_2, 15% O_2; storing at 0 and 5°C. Modified atmosphere packaging was injected into the bags with chamber machine C-200 Multivac. After application of gas bags are packed in corrugated cardboard box of 50 cm length, 32 cm long and 32 in width. The experiment was stopped 6 days under these conditions.

Storage

Four replicates packaged bags of each gas mixture were placed at 0 and 5°C.

Gas analysis

At the beginning and end of the experiment, the composition of O_2 and CO_2 inside the packaged bag was examined by analyzer WITT PA 6.

Experimental design to analyze the effect of modified atmosphere red gladiolus with three gas mixtures stored at temperature of 0 and 5°C. We analyzed the effect of the factors on the percentage carbon dioxide and percentage oxygen. The design is a multi-standard Categorical factor consisting of all combinations of the levels of the factors. There are a total of 12 runs in the design.

Fresh weight loss and flower opening

Fresh weight loss

At the beginning and end of the time of MAP, the spikes were weighed to calculate weight loss by MAP.

Flower opening

After storage for 6 days in MAP at 0 and 5°C, ten spikes of each mixture gas placed in water and held at 20 ± 2 °C by 6 days in vase. After 6 days the number of spikes opened by rod was counted.

Experimental design to analyze the effect of modified atmosphere in the number of spikes open and weight in grams in red gladiolus rods in three gas mixtures stored at 0 and 5°C. This experimental design Categorical Multi-factor, to estimate the effects of two categorical factors. The factorial design is a standard consisting of all combinations of the levels of the factors. There are a total of 36 runs in the design.

Statistical analysis

Analysis of variance (ANOVA) and the mean test with the LSD method with 95% confidence level for vase life and MAP, the effect of interactions in the response were performed with Statgraphics centurion version XVI.

RESULTS AND DISCUSSION

Effect of type of gas mixture and temperature on the decrease in fresh weight spikes gladiolus

Table 1 show that there were significant differences between the different conditions of temperature on fresh weight loss of spikes stored in MAP. P-values test the statistical significance of each of the factors. The fresh weight loss at 5°C was less, indicating the temperature is required to retain the quality, since by reducing fresh weight loss, also prevents heat damage that occurs. The low temperature also has favorable impact, slowing damaging several metabolic processes and, especially on delaying aging floral.

Interactions in the graph shows that the spikes had less weight loss when stored in packaging with the mixture 3 to 0°C and packing with mixture 1 to 5°C (Figure 1).

Effect of type of gas mixture and temperature on the decrease in flowers open after vase life gladiolus

P-values test the statistical significance of each of the factors. Since a P-value, the temperature is less than 0.05; this factor has a statistically significant effect on % open flowers with a 95.0% confidence level (Table 2). In the interaction graph shows that the red gladiolus stored in packaging mixed 3 at 0 and 5°C, are those that manage to open at a higher rate (Figure 2).

Figure 3 shows the appearance of the cut flower red gladiolus after 6 days of MAP at 0°C and 6 days of vase life at 20°C. In the Figure 4, there is the aspect of the spikes red gladiolus flowers after 6 days of MAP at 5°C and 6 days in vase life at 20°C. In both cases it is

Table 1. Analysis of Variance for weight reduction (g).

Source	Sum square	DF	Mean square	Ratio-F	P-value
Main effects					
A: Temperature, °C	5.44444	1	5.44444	7.21	0.0117
B: Gas mixture	1.16667	2	0.583333	0.77	0.4710
Interactions					
AB	5.72222	2	2.86111	3.79	0.0342
Waste	22.6667	30	0.755556		
Total (corrected)	35.0	35			

Table 2. Analysis of variance for % open flowers.

Source	Sum of square Cuadrados	DF	Mean square	Ratio-F	P- value
Main effects					
A: Temperature, °C	920.111	1	920.111	6.51	0.0161
B: Gas mixture	544.222	2	272.111	1.92	0.1636
Interactions					
AB	124.222	2	62.1111	0.44	0.6486
Waste	4242.67	30	141.422		
Total (corrected)	5831.22	35			

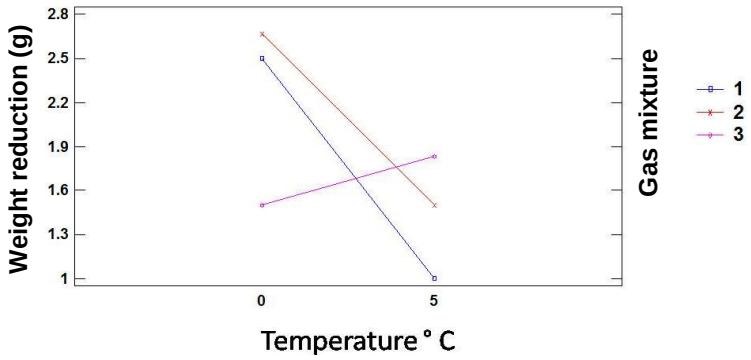

Figure 1. Graphical interactions-gas mixture temperature on the weight loss (g), in red gladiolus after 6 days of storage in MAP.

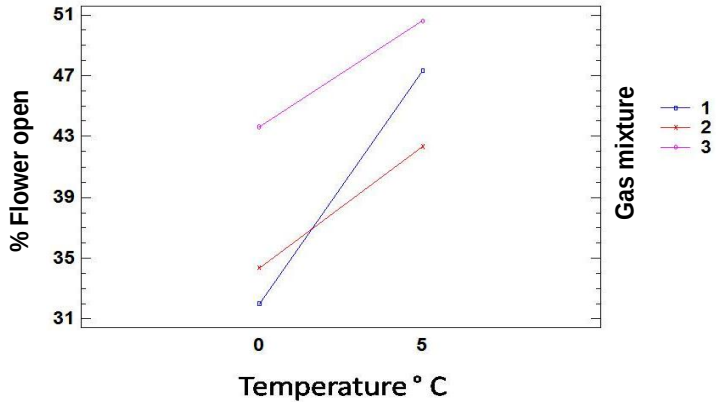

Figure 2. Graphical interactions-Gas mixture temperature on the percentage of open flowers red gladiolus rods after 6 days of being in the vase after being stored in MAP for 6 days at 0 and 5°C.

Figure 3. Red gladiolus rods after 6 days of vase life at 20°C, cut flower from bags stored in MAP at 0°C: (a) Mixture 1, (b) Mixture 2, (c) Mixture 3.

Figure 4. Red gladiolus rods after 6 days of vase life at 20°C, cut flower from bags stored in MAP at 5°C: (a) Mixture 1, (b) Mixture 2, (c) Mixture 3.

Table 3. Analysis of variance for % dioxide carbon.

Source	Sum square	Df	Mean square	Ratio-F	P-value
Main effects					
A: Temperature, °C	1.92	1	1.92	50.09	0.0004
B: Gas mixture	0.5	2	0.25	6.52	0.0313
Interactions					
AB	0.02	2	0.01	0.26	0.7787
Waste	0.23	6	0.0383333		
Total (corrected)	2.67	11			

observed that the flowers look good in color and shape.

Determination of concentration of carbon dioxide inside packaged bags stored in different atmosphere and temperatures

P-values test the statistical significance of each of the factors. Since 2-P values are less than 0.05, these factors have a statistically significant effect on percentage carbon dioxide with a 95.0% confidence level (Table 3). Interactions in the graph shows that the bags packed with 3 mixture have higher values of carbon dioxide (Figure 5).

Determination of concentration of oxygen inside packaged bags stored in different atmosphere and temperatures.

P-values test the statistical significance of each of the factors. Since 2-P values are less than 0.05, these factors have a statistically significant effect on percentage oxygen with a 95.0% confidence level (Table 4). Interactions

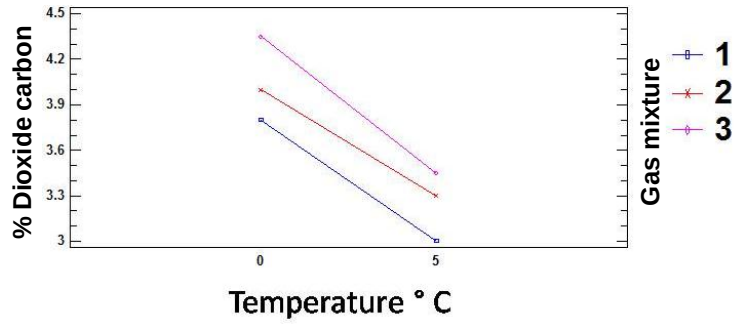

Figure 5. Graphic interaction-gas mixture temperature on the percentage of carbon dioxide in bags with rods of red gladiolus packed with MAP and stored at 0 and 5°C for 6 days.

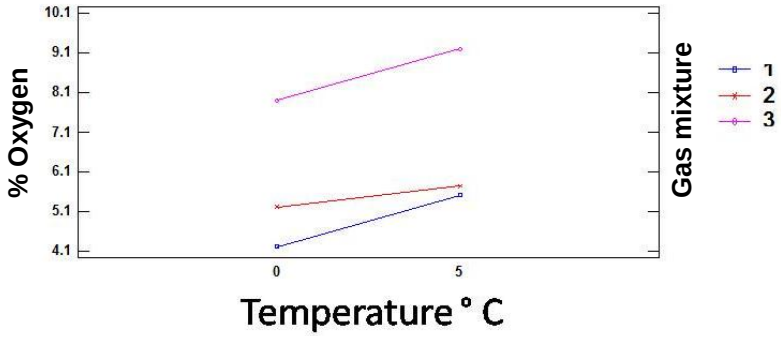

Figure 6. Graphical interactions-temperature gas mixture of oxygen percentage in bags with rods with red gladiolus MAP and stored at 0 and 5°C.

Table 4. Analysis of variance for % Oxygen.

Source	Sum square	Df	Mean square	Ratio-F	P-value
Main effects					
A: Temperature, °C	3.3075	1	3.3075	18.99	0.0048
B: Gas mixture	31.3817	2	15.6908	90.09	0.0000
Interactions					
AB	0.375	2	0.1875	1.08	0.3986
Waste	1.045	6	0.174167		
Total (corrected)	36.1092	11			

in the graph shows that the bags packed with the mixture 3 have the highest values of oxygen (Figure 6).

The decrease in O_2 concentration and increase CO_2 concentration were observed which were reported by other researchers previously (Antmann et al., 2008; Simón et al., 2010, Koushki et al., 2011). With the results obtained, although the mixture 1 show less fresh weight reduction, the mixture 3 represents the best treatment because floral stem stored in this mixture had a higher number of open flowers during vase life, also allows high levels of carbon dioxide during storage in the two conditions temperature, which inhibits the growth of some fungi. In contrast modified atmosphere on packed dried apricot were observed that the percentage of CO_2 changed from the initial 31.53 to 1.53 (Ranđelovic et al., 2012). But agrees with reports indicating that modified atmospheres, richer in CO_2 and poorer in O_2 than air, are assumed to be able to reduce respiration rate, decay and physiological deteriorations of vegetables, which results in shelf-life extension (Antmann et al., 2008).

Conflict of Interest

The authors have not declared any conflict of interest.

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