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INFLUENCE OF PACKAGING MATERIAL AND STORAGE DURATION ON POSTHARVEST QUALITY OF MARIGOLD FLOWERS IN DIFFERENT SEASONS

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ABSTRACT

A study was carried to examine the efficacy of packaging materials (polythene, CFB boxes, ice boxes, bamboo baskets, gunny bags and onion mesh bags) and storage duration (0, 1, 2 and 3 days) on post-harvest quality of loose flowers of marigold var. Jafri during rainy and winter season. The shelf life of marigold flowers was better (6.00 days) in winter season as compared to rainy season (3.66 days), accompanied with lesser loss in physiological weight, no change in colour intensity, higher moisture content, lesser spoilage and more freshness index. Among all the packages, ice boxes, CFB boxes and polythene packages showed better results in comparison to gunny bags and onion mesh bags. In regard to storage duration, one day storage was better in comparison to two and three days in both the seasons. Comparison of two seasons revealed better performance in winter season with slight effect on keeping quality of flowers.

Keywords: Marigold, Packaging, Post-harvest, Storage, Shelf life

Marigold is one of the most important flower crops grown commercially in different parts of India especially in plains. Marigold is a short duration and beautiful blooming crop belonging to family Asteraceae. The uses of marigold are manifold, often referred as “versatile crop with golden harvest”. In India, marigold flowers are used in folk-art as they are powdered and dried to produce yellow colour used for decorating homes in villages. Flowers are the richest source of xanthophyll and lutein which are major pigments present in flowers (Henken, 1992). The flower extract being rich in lutein (carotenoid) acts as a colouring agent and is used as poultry feed to impart yellow color to egg yolk (Kaul and Bedi, 2006). It has valuable essential oils with strong and penetrating odour due to which it is used in perfumery and has medicinal values; its infusion is prescribed as vermifuge, diuretic and carminative (Gupta and Vasudeva, 2012). The marigold plants are useful for suppressing nematode population in the field (Bhattacharyya, 2017) and dried petals are used in beauty aids (Rawia *et al*., 2006).

Presently, marigold is grown for fresh flower trade with obsolete technologies and lack of improved method of harvesting, packaging, storage duration and transporting. Under normal conditions, shelf life of flowers varies from 2-3 days depending upon the season due to its perishable nature. The new cultivars and latest production technologies have made the year-round production possible but the advancement in postharvest management is the demand of the hour to overcome the economic losses during glut through suitable storage and packaging (Bhattacharjee and De, 2005; Tsegaw *et al*., 2011). During transportation or post-harvest handling, approximately 20% of the fresh products are lost. So there is an urgent need for effective and adaptable transport system and postharvest conditions (Farooq *et al*., 2004). This makes the storage of flowers, an essential part of orderly marketing and extension of shelf life. Appropriate storage methods can offer the possibility to earn more and resist unwanted losses.

Any packaging technology which focuses on longer period of storage will add to the market value of crop and enable the small farmers to earn higher profits (Devi *et al*., 2017). Keeping in view the increasing demand of loose flowers of marigold, need for enhancing their postharvest life, dearth of facilities to stock up produce in cold stores or cold chain transportation at economical prices and paucity of research on improvement in quality of loose flowers with economical storage and packaging, the present study was undertaken to study the effect of different packaging materials and storage durations for extending shelf life of loose flowers of marigold during different seasons.

MATERIALS AND METHODS

The present investigation was carried out at the Research Farms and Laboratories of the Department of Floriculture and Landscaping, Punjab Agricultural University, Ludhiana. The seeds of marigold var. Jafri were sown on the raised beds in the first week of July

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and October and the thirty-day old seedlings were transplanted in the first week of August and November respectively in the fields. The August transplanted crop came into bloom in the month of November-December and November transplanted crop bloomed in the month of February-March. The flowers were harvested at fully open stage. Experiments were laid out in factorial completely randomised design under room conditions with 7 treatments and 3 replications. After harvest, the keeping quality of flower was assessed by using different packaging materials (polythene, 100 gauge; corrugated fibre board boxes, CFB box; ice boxes, bamboo baskets, gunny bags and onion mesh bags) and storage durations (0, 1, 2 and 3 days). Fresh flowers without any packaging and storage durations served as control. The quality parameters namely, shelf life, moisture content (%), physiological loss in weight (%), change in colour (by Royal Horticultural Society Colour Chart), spoilage (%), freshness index and market acceptability (scoring on visual basis) were recorded after storage.

Shelf life of flowers was recorded as number of days they remained fresh under ambient conditions after particular storage duration. The shelf life began from the day the flowers were removed from package till 50% of flowers showed abscission. Moisture content was calculated by following formula:

$$\text{Moisture content (\%)} = \frac{\text{Fresh weight - Dry weight}}{\text{Fresh weight}} \times 100$$

Physiological loss in weight (%) was calculated by following formula:

$$\text{Physiological loss in weight of flowers (\%)} = \frac{\text{Initial weight - Final weight}}{\text{Initial weight}} \times 100$$

The Colour of petals was noted before, after and at the end of shelf life using Royal Horticultural Society colour chart. Freshness index was calculated as the number of flowers that remained fresh after storage in different packages to the total number of flowers. (A flower was considered as fresh when all its petals were turgid without any sign of senescence even at its tip.)

$$\text{Freshness index} = \frac{\text{Number of fresh flowers}}{\text{Total no of flowers}} \times 100$$

Spoilage (%) was calculated from the spoiled flowers and total number of flowers in particular package after storage duration by following formula

$$\text{Spoilage (\%)} = \frac{\text{Number of spoiled flowers}}{\text{Total no of flowers}} \times 100$$

(A flower was considered spoiled when its 50% petals showed senescence or browning.)

For market acceptability, the flowers after removing from different packages were taken to florists and according to their views pertaining to marketability, the grade of excellent (5 scores), very good (4 scores), good (3 scores) and poor (2 scores) or unacceptable (1 score) were given to flowers.

Data was subjected to statistical analysis of variance (ANOVA) using SAS software (version 9.2, SAS Institute Inc., Cary, NC, USA). Mean comparisons to calculate significant differences were performed using Least Significant Differences (LSD) test at 0.05 level of probability.

RESULTS AND DISCUSSION

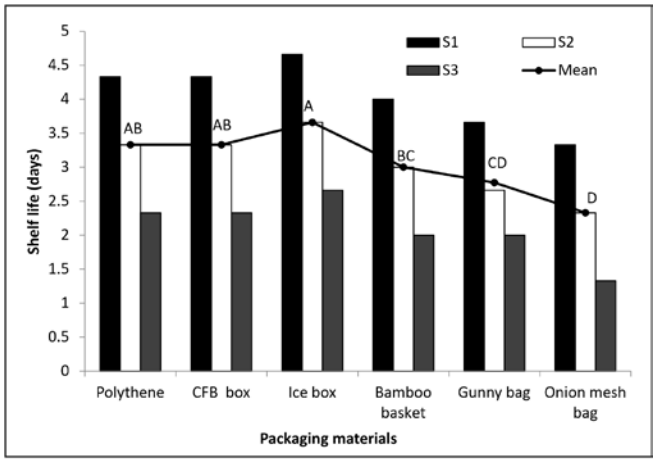
Post-harvest characteristics of marigold var. Jafri were significantly affected by different packaging materials and storage durations.

Shelf life

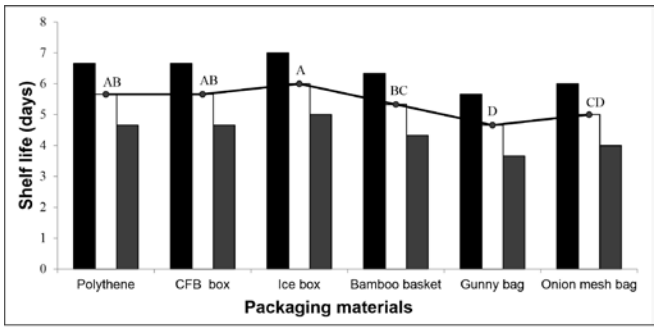
During rainy season, flowers packed in different packaging materials showed significant difference with maximum shelf life in ice box and minimum in onion mesh bag (Fig.1). Shelf life of flowers decreased with prolonged storage duration irrespective of the packaging material. Among three storage durations, flowers stored for one day recorded maximum shelf life (4.05 days) as compared to two days (3.05 days) or three days (2.11 days). Whereas in winter season, maximum shelf life was recorded in ice box (6.0 days) and minimum in gunny bag (4.66 days). Among different storage durations, results were quite similar to rainy season. Highest shelf life was recorded in flowers during winter season as temperature and humidity were more favourable in winter season in comparison to rainy season. Similar findings were reported by Nirmala and Reddy (1994) and Nagaraja *et al*. (1999) where significant increase in shelf life was observed due to packaging and storage durations.

Moisture content

The moisture content after storage showed significant difference when packed in different packaging materials for different storage durations during rainy season (Table 1). Among all the packaging materials, flowers packed in ice box recorded maximum moisture content after storage (76.38 %), followed by CFB (76.12%). Moisture content of flowers stored in polythene (74.37 %) was statistically at par with ice box and CFB after storage. However, onion mesh bag recorded minimum moisture content (71.13 %). Among storage durations, one day storage recorded maximum moisture content (76.60%) in flowers and least (72.05 %) was recorded in three days storage that decreased with storage in all packages. In contrast to rainy season,



(a)

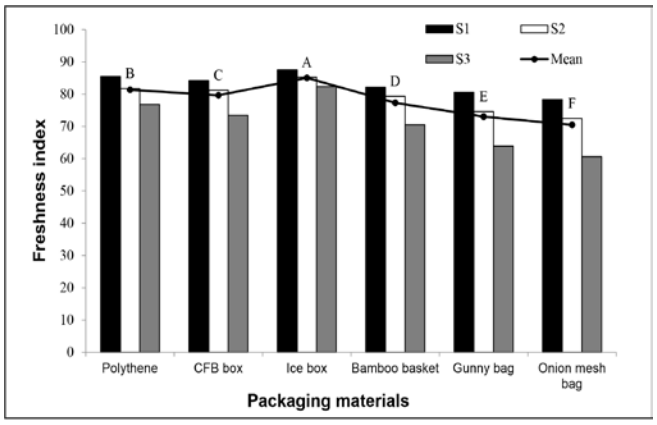


(b)

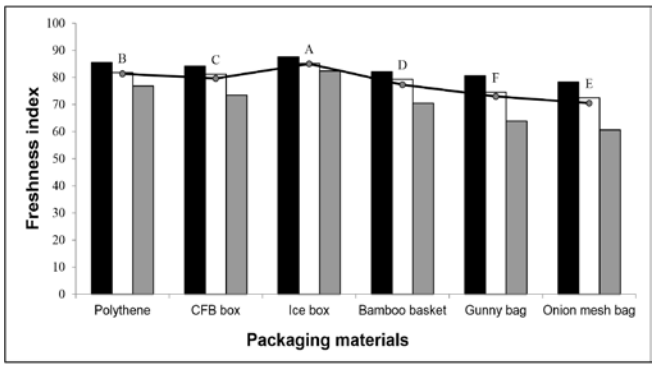
Different uppercase letters represent significant differences between mean of packaging materials

.*S_1-one day, S_2-two day, S_3-Three day.and mean –mean for packaging material irrespective of storage duration

Fig. 1. Effect of packaging materials and storage durations on shelf life of flowers of marigold var. Jafri No-1 during rainy (a) and winter (b) season



(a)



(b)

Different uppercase letters represent significant differences between mean of packaging materials

.*S_1-one day, S_2-two day, S_3-Three day.and mean –mean for packaging material irrespective of storage duration

Fig. 2. Effect of packaging materials and storage durations on freshness index of marigold var. Jafri during rainy (a) and winter (b) season

winter season showed better results in retaining the moisture content of flowers (Table 2). The fresh flowers recorded maximum moisture content (88.72 %) during winter season and it declined with increasing storage duration in all packages. The maximum moisture content (82.65 %) was recorded in flowers packed in ice box and least (73.14%) was recorded in gunny bag after storage. Among storage duration, three days storage recorded minimum moisture content (75.13%) and moisture content decreased with increase in storage durations. Among all the packaging materials, ice box, CFB box and polythene retained higher moisture content in flowers as compared to other packages. Results were similar to the findings of Devi *et al*. (2017) where bamboo baskets performed better than onion mesh bags and gunny bags. Positive influence of ice box and CFB box on moisture content could be attributed to thermal isolation, resistance to moisture and weathering (Jawaharlal *et al*., 2012).

Weight

Different packaging materials and storage durations significantly influenced the weight of flowers (Table 2). The flowers packed in onion mesh bag during rainy season recorded maximum loss in physiological weight (25.49 %) after storage and flowers packed in ice box and polythene recorded least loss in physiological weight 10.14 and 11.23 %, respectively. Loss in physiological weight increased with increasing storage duration. Flowers packed for three days recorded more loss in physiological weight (26.00 %) than one day and two days storage. In comparison to rainy season, physiological weight loss was less in winter season. The flowers packed in ice box exhibited minimum loss in physiological weight (4.52 %). However, flowers packed in gunny bag exhibited maximum loss in physiological weight (20.89 %). Three days storage recorded higher loss in physiological weight in comparison to one day and two days (17.88 %). Loss in physiological weight is

Table 1. Effect of packaging materials and storage durations on moisture content of flower petals of marigold var. Jafri during rainy and winter season

Packaging	Moisture content in petals (%)							
	Rainy season				Winter season			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
Polythene	76.56^{abc}	74.07^{abcd}	72.48^{cd}	74.37^{AB}	82.95^{bc}	79.72^{e}	76.99^{fg}	79.89^{B}
CFB box	80.19^{a}	74.69^{abcd}	73.48^{bcd}	76.12^{A}	83.68^{a}	79.87^{de}	75.92^{gh}	79.82^{B}
Ice box	79.24^{b}	75.34^{abcd}	74.56^{abcd}	76.38^{A}	84.90^{a}	83.17^{abc}	79.90^{cd}	82.65^{A}
Bamboo basket	75.32^{abcd}	72.37^{cd}	70.63^{cd}	72.78^{BC}	81.61^{cd}	78.61^{ef}	74.68^{hi}	78.30^{C}
Gunny bag	75.63^{abcd}	72.20^{cd}	70.95^{cd}	72.93^{BC}	76.50^{gh}	72.48^{j}	70.43^{k}	73.14^{E}
Onion mesh bag	72.67^{cd}	70.54^{cd}	70.19^{d}	71.13^{C}	78.89^{e}	75.35^{gh}	72.85^{ij}	75.70^{D}
Mean	76.60^{A}	73.20^{B}	72.05^{B}		81.42^{A}	78.20^{B}	75.13^{C}	
Control (fresh flowers)	85.63				88.72			
LSD (p=0.05)	P=1.96 S=1.38 PxS= 1.09				P=1.96 S=1.38 PxS=1.08			

*Different uppercase letters in the vertical column represent significant differences between packaging materials and in the horizontal row represent significant differences between storage durations. Different lowercase letters represent significant differences between interaction of packaging materials and storage durations. *S1-one day, S2-two days, S3-three days

Table 2. Effect of packaging material and storage duration on physiological weight loss in marigold flowers var. Jafri during rainy and winter season

Packaging	Physiological loss in weight (%)							
	Rainy season				Winter season			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
Polythene	5.42^{j}	12.64^{fg}	15.61^{ef}	11.23^{E}	2.17^{kl}	5.46^{ijk}	9.68^{efg}	5.77^{D}
CFB box	9.44^{ghi}	16.95^{de}	28.73^{b}	18.38^{D}	2.83^{kl}	6.30^{hij}	14.18^{d}	7.77^{C}
Ice box	6.57^{ij}	8.20^{ijk}	15.66^{ef}	10.14^{E}	1.50^{l}	4.09^{jkl}	7.96^{ghi}	4.52^{D}
Bamboo basket	11.51^{gh}	20.59^{cd}	31.77^{ab}	21.29^{C}	5.47^{ijk}	11.65^{def}	24.79^{ab}	13.97^{B}
Gunny bag	18.07^{de}	23.47^{c}	31.29^{ab}	24.27^{B}	13.30^{d}	21.33^{c}	28.03^{a}	20.89^{A}
Onion mesh bag	20.59^{cd}	22.96^{c}	32.92^{a}	25.49^{A}	9.36^{fgh}	12.79^{de}	22.64^{bc}	14.93^{B}
Mean	11.93^{C}	17.47^{B}	26.00^{A}		5.77^{C}	10.27^{B}	17.88^{A}	
Control (fresh flowers)	13.42				1.48			
LSD (p=0.05)	P=1.20 S=8.53 PxS=1.63				P=5.96 S=7.61 PxS=3.24			

*Different uppercase letters in the vertical column represent significant differences between packaging materials and in the horizontal row represent significant differences between storage durations. Different lowercase letters represent significant differences between interaction of packaging materials and storage durations. *S_1-one day, S_2-two day, S_3-Three day.

strongly influenced by temperature and relative humidity. The reduced loss of physiological weight in ice box and polythene could be attributed to high moisture content in these packages (Ahmad *et al*., 2011). Increased loss in physiological weight and moisture content of stored flowers results in lower shelf life (Nicholas, 1966).

Colour intensity

The change in colour intensity was noticed after removal of the flowers from different packages. It was depicted that when the flowers were removed after storage under different packaging materials, no change in colour was observed in both the seasons. The flowers kept under different packages and storage durations belonged to orange group with colour code 25 B which was similar to fresh flowers. Among storage durations, change in colour intensity showed no specific variation in colour of the petals.

Freshness index

Freshness index of the flowers showed significant variation after removal of the flowers from different packaging materials under different storage durations (Fig. 2). Maximum freshness index (85.04) was exhibited by the flowers packed in ice box and minimum freshness index (70.49) was recorded in the flowers packed under onion mesh bag during rainy season. Freshness index of the flowers stored for one day (83.05) was significantly higher than the freshness index of the flowers stored for two days (79.10) and

Table 3. Effect of packaging material and storage duration on spoilage of marigold flowers var. Jafri during rainy and winter season

Packaging	Spoilage (%)							
	Rainy season				Winter season			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
Polythene	19.95^{cdef}	17.43^{defg}	22.23^{bcde}	19.87^{C}	13.23^{bcd}	11.46^{de}	12.32^{cde}	12.34^{C}
CFB box	17.13^{fg}	19.47^{defg}	27.82^{bc}	19.47^{C}	11.15^{de}	11.15^{de}	15.63^{b}	12.64^{C}
Ice box	13.43^{g}	15.06^{fg}	17.07^{defg}	15.19^{D}	10.30^{e}	11.49^{de}	13.81^{bcd}	11.87^{C}
Bamboo basket	15.55^{fg}	19.95^{cdef}	28.20^{b}	21.23^{BC}	11.50^{de}	13.23^{bcd}	18.63^{a}	14.45^{B}
Gunny bag	20.72^{defg}	24.46^{cdef}	38.62^{a}	23.93^{B}	13.28^{bcd}	15.65^{b}	21.45^{a}	16.79^{A}
Onion mesh bag	20.39^{efg}	24.53^{bcd}	37.56^{a}	27.49^{A}	11.44^{de}	14.92^{bc}	15.63^{b}	14.00^{B}
Mean	16.20^{C}	18.82^{B}	27.25^{A}		11.81^{C}	12.98^{B}	16.23^{A}	
LSD (p=0.05)	P=2.13 S=1.51 PxS=2.06				P=0.89 S=0.63 PxS=5.82			

*Different uppercase letters in the vertical column represent significant differences between packaging materials and in the horizontal row represent significant differences between storage durations. Different lowercase letters represent significant differences between interaction of packaging materials and storage durations. *S_1-one day, S_2-two day, S_3-Three day.

Table 4. Effect of packaging material and storage duration on market acceptability of marigold flowers var. Jafri during rainy and winter season

Packaging	Market Acceptability					
	Rainy Season			Winter season		
	S_1	S_2	S_3	S_1	S_2	S_3
Polythene	4	3	1	5	5	3
CFB box	4	3	1	5	5	3
Ice box	4	3	2	5	5	4
Bamboo basket	3	2	1	5	5	2
Gunny bag	3	2	1	5	3	1
Onion mesh bag	3	2	1	5	5	2

*5-Excellent, 4-Very good, 3-Good, 2-Fair, 1-Non acceptable

three days (71.29). Variation in freshness index was less in winter season in comparison to rainy season as temperature played an important role in retaining the freshness of flowers (Fig. 2). Freshness index of flowers decreased with prolonged storage duration, irrespective of the packaging material used. Among the three storage durations, flowers packed for one day recorded maximum 88.39) and the flowers stored for three days recorded minimum (83.65) freshness index during winter season. Among the various packaging materials, maximum freshness index (88.86) was recorded in the flowers packed in ice box. Similar results were reported by Madiah and Reddy (1992) where high freshness index was recorded in flowers packed in polythene. Retention of freshness of flowers in icebox, polythene and CFB box could be due to their ability to maintain humid conditions in the vicinity of flowers by acting as a barrier for loss of moisture inside the packing.

Spoilage

Spoilage percentage was significantly affected after removal of the flowers from different packaging materials and storage durations in rainy season (Table 3). The flowers packed in onion mesh bags exhibited maximum spoilage (27.49 %) and minimum spoilage was exhibited in flowers packed in ice box (15.19 %). It was observed that spoilage of flowers increased with increasing storage duration. Flowers stored for three days recorded significantly higher spoilage (27.25 %) as compared to the flowers stored for two days irrespective of the packaging material. Spoilage percentage was least during winter season in comparison to rainy season. The data depicted in Table 3 shows that among all the packaging materials, flowers packed in ice box recorded minimum spoilage (11.87 %, whereas flowers packed in gunny bags recorded maximum spoilage (16.79 %). In regard to storage duration, maximum spoilage was exhibited in flowers stored for three days (16.23%) in comparison to one day and two days. The reason behind lesser spoilage of flowers packed in ice box, CFB box and polythene could be their ability to maintain optimum humidity which leads to moisture

retention and also enhances shelf life (Nagaraja *et al*., 1999). Nirmala and Reddy (1994) also reported similar results in jasmine flowers, where packings without ventilation resulted in maintaining optimum humidity and ratio of oxygen and carbon dioxide, moisture retention and thus reducing the rate of evapotranspiration leading to lower spoilage.

Market acceptability

Flowers in winter season showed better market acceptability as compared to rainy season (Table 4). It was found that among different packaging materials, flowers packed in ice box obtained the highest score of 4 in rainy season and 5 in winter season. However, with increase in storage duration, the acceptability of flowers declined to score 2 in rainy season and score 4 in winter season. Among different packaging materials, flowers packed in bamboo basket, gunny bag and onion mesh bag were not acceptable after three days.

Authors' contribution

Conceptualization of research work and designing of experiments (SJ, TV); Execution of field/lab experiments and data collection (TV, SJ); Analysis of data and interpretation (SJ, TV); Preparation of manuscript (TV, SJ)

LITERATURE CITED

Ahmad I, Asif M, Amjad A and Ahmad S 2011. Fertilization enhances growth, yield and xanthophyll contents of marigold. *Turk J Agric for* **35**: 641-48.

Bhattacharyya M 2017. Use of marigold (*Tagetes* sp.) for the successful control of nematodes in agriculture. *Pharma Innov J* **6**(11): 01-03.

Bhattacharjee S K and De L C 2005. Post harvest technology of flowers and ornamental plants. *Agris FAO* pp. 87-97.

Devi P M, Hemanta L, Thokchom R, Chakrabarty S and Dhua R S 2017. A Study on different packaging materials affect shelf life of marigold at different harvesting seasons under west Bengal condition. *Int J Curr Microbiol App Sci* **6**(8):1665-73.

Farooq U A, Iftikhar A and Khan A 2004. Storage and vase life of cut rose flower as influenced by various packaging material. *Int J Agric Biol* **6**: 237-39.

Gupta P and Vasudeva N 2012. Marigold, a potential ornamental plant drug. *Hamadard Medicus* **55:** 45-59.

Henken H 1992. Chemical and physical behaviour of feed carotenoids and their effects on pigmentation. *Poult Sci* **71**:711-17.

Jawaharlal M, Thameraiselvi S P, Ganga M 2012. Packaging technology for export of jasmine (*Jasminum sambac*Ait*.)* flowers. *J Hort Sci* **7**(2): 180-89.

Kaul K and Bedi Y S 2006. Natural source of lutein: Marigold (*Tagetes erecta* L.) Introduction, cultivation, selection and quality improvement under hill conditions of Himachal Pradesh. *NISCAIR Online Periodicals Repository* **14**:167-71.

Madiah D and Reddy T V 1992. Influence of polythene packaging on the post-harvest life of tuberose (cv Single) florets. *Karnataka J Agric Sci* **7**: 154-57.

Nagaraja G S, Gowda J V N and Farroqi AA 1999. Shelf life of tuberose flowers as influenced by packaging and ventilation. *Karnataka J Agric Sci* **12**(1-4):239-42.

Nicholas R 1966. Ethylene production during senescence of flowers. *J Hort Sci* **41**: 279-90.

Nirmala S and T V Reddy 1994. Shelf life of jasmine flowers as influenced by packaging and ventilation. *Mysore J Agric Sci* **27**: 13-19.

Rawia A E, Lobna S T and Soad M M I 2006. Alleviation of adverse effects of salinity on growth and chemical constituent of marigold plants by using glutathione and ascorbate. *J Appl Sci Res* **7**: 714-21.

Tsegaw T, Tilahun S and Humphries 2011. Influence of pulsing biocides and preservative solution treatment on the vase life of cut rose (*Rosa hybrida* L.) varieties. *Ethiop J App Sci Technol* **2** (2): 1-18.