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Study on the performance of new African marigold (*Tagetes erecta* L.) genotypes for quality parameters

Ibrahim Ismail Mulla, P Prasanth, G Jyothi, Zehra Salma and S Praneeth Kumar

Abstract
This study aims to investigate the performance of various African Marigold (*Tagetes erecta* L.) genotypes for important quality parameters such as shelf life, total carotenoid content, and flower color intensity. Nine genotypes were evaluated to determine their suitability for cultivation in the Southern Zone of Telangana, India. The results indicate significant variations among the genotypes, providing valuable insights for cultivar selection based on specific quality attributes. The maximum shelf-life was observed in T_4- Arka Vibha (6.40 days) and the lowest shelf-life (3.65 days) was registered in T_9-Pusa Narangi Gainda. The highest total carotenoid content was observed in T_2-Arka Subha (756.50 mg/100 g) and the lowest total carotenoid content.
(123.60 mg/100 g) was registered in T_7-KAU M1. The RHS colour chart was used to identify the colour of the flower, the genotypes displayed a range of colors from yellow to orange. Arka Subha and Arka Abhi produced vibrant yellow and orange blooms, respectively. The compactness of the flowers also varied among genotypes.

Keywords: African marigold, shelf life, total carotenoid content and genotypes

Introduction
Marigold, a loose flower crop, holds substantial economic significance in horticulture. Among the various species of marigold, African Marigold (*Tagetes erecta* L.) stands out due to its economic importance and widespread cultivation. Marigold is deeply rooted in cultural and religious practices, making it a high-demand commodity in various festivals and ceremonies in Telangana, India. Given its importance, continuous efforts are made to develop new genotypes that can meet the demands of both farmers and consumers.
There are 33 species in the genus Tagetes (Rydberg 1915) [9], with *Tagetes erecta, Tagetes patula, Tagetes minuta*, and *Tagetes lucida* among the prominent species. Among them, African Marigold (*Tagetes erecta* L.) is a significant species of marigold that is one of the most significant economically exploited flower crops and is a member of the Asteraceae family. The God 'Tages,' who was renowned for his beauty, inspired the name 'Tages' for Tagetes. It is originated in Central and South America, particularly Mexico, travelled to Spain, and during the first half of the 16th century, and gained notoriety under the name "Rose of Indies" (Kaplan, 1960).
According to Tomar *et al.* (1972) [12], cultivar performance varies with geography, season, and other growing variables. As a result, a well-known cultivar that thrives in one region may struggle to thrive in another place with a different climate. The need to gather and assess the available genotypes arises from the attempt to choose a high- yielding variety that is suitable for the area. Furthermore, the demand for promising genotypes is increased by the sensitivity of current cultivars to various biotic stresses. The selection of appropriate cultivars for a specific locality determines the eventual yield, production of high-quality flowers, pigment contents in blooms, and resistance to biotic influences.
Yellow, orange, and red pigments are produced by carotenoids in plants. According to studies, carotenoids are good for the skin, eyes, and heart as well as preventing cancer, age-related macular degeneration (AMD), and coronary heart disease from impairing vision (Boonnoun *et al.*, 2012) [1]. The poultry industry frequently uses the orange-colored marigold, a rich source of carotenoid pigment, as a nutritional supplement to improve the colour of chicken skin and egg yolks (Naik, 2003) [6].

Carotenoids that are derived from flowers are utilised industrially and commercially in food colouring, dietary supplements, animal feed additives, and medications. The colour of ornamental fish and fish fillets can be improved by adding marigold pigments to poultry feed (Boonyaralpalin, 1989) [2]. At present, Bangalore (Karnataka), Hyderabad (Telangana), Satyamangalam forest (Tamil Nadu), and Cochin (Kerala) are the places where marigold carotenoids are commercially extracted. It is exported to countries like Australia, Canada, Mexico, Peru, USA, Japan, Spain, Romania, Netherlands, Turkey, Poland, Italy, and many more. Quality of the flower is an important trait for commercial importance, the size, shape and their compactness along with carotenoid content of flowers will decide the marketability of marigold flowers. In view of this, the present investigation has been carried out with an objective of testing the new genotypes of marigold at Southern Telangana Zone.

Material and Methods

The experiment was conducted during the *Rabi* season of 2022-2023 at the Floricultural Research Station, ARI, Rajendranagar, Hyderabad, under a randomized block design. Nine genotypes, including Arka Bhanu, Arka Subha, Arka Abhi, Arka Vibha, Punjab Gainda 1, BM-4, KAU M1, KAU M2, and Pusa Narangi Gainda (check), were evaluated. Parameters such as shelf life, total carotenoid content, and color intensity were assessed.

The Total carotenoid content (mg/100 g) was estimated by using a sample of 5 g, grinded in a mortar and pestle with acetone. The extract was decanted into a conical flask. Extraction was continued till the entire pigment were extracted and the residue became colorless. The extract was transferred to a separating funnel, then 10- 15 ml of petroleum ether and water containing 5 percent anhydrous sodium sulphate were added. Extraction of acetone phase was repeated with small volume of petroleum ether until no more colours was extracted. A small amount of anhydrous sodium sulphate was added to absorb the excess water and volume was made up with eluent (3% acetone in petroleum ether). The colour was measured at 452 nm using eluent as blank in spectrophotometer. Results were expressed as mg/100 g of material (Ranganna, 1995) [8].

Calculation

$$\text{Total Carotenoids (Mg/100 g sample)} = \frac{3.857 \times \text{optical density} \times \text{volume made up} \times \text{dilution} \times 100}{1000 \text{ X Weight of sample}}$$

Results and Discussions

Quality parameters Shelf life

The genotypes differed significantly in respect to Shelf-life. The mean values ranged from 3.51 to 6.40 days. The maximum shelf-life was observed in T_4- Arka Vibha (6.40 days), which was at par with T_6- BM-4 (6.37 days), and followed by T_3-Arka Abhi (5.93 days) without any significant difference. However, the lowest shelf-life (3.65 days) was registered in T_9-Pusa Narangi Gainda, followed by T_7-KAU M1 (3.65 days). Remaining genotypes showed intermediate results. All the genotypes recorded more shelf life than check Pusa Narangi Gainda.

The different in shelf life of marigold genotypes might be due to environmental conditions and the genetic makeup of the genotypes (Patokar *et al.*, 2018) [7]. Similar results were observed by Divya *et al*. (2018) [3], Samantray, Palai (2018) [10] in other marigold genotypes.

Total carotenoid content (mg/100 g)

The genotypes differed significantly in respect to carotenoid content. The mean values ranged from 123.60 to 756.50 mg/100 g. The highest total carotenoid content was observed in T_2-Arka Subha (756.50 mg/100 g), and significantly followed by T_3-Arka Abhi (477.60 mg/100 g). However, the lowest total carotenoid content (123.60 mg/100 g) was registered in T_7-KAU M1, followed by T_8-KAU M2 (189.45 mg/100 g). Remaining genotypes showed intermediate results. When compared to check, T_9 - Pusa Narangi Gainda, except T_2-Arka Subha, T_3-Arka Abhi and T_1- Arka Bhanu all other genotypes recorded less carotenoid content.

The total carotenoid content variation might be because of colour of flower and different genetic makeup of genotypes. The results are in conformity with the finding of Thirumalmurugan *et al.* (2020) [11] and Mahanta *et al*. (2020) [5] in marigold.

Colour intensity

Visual inspection of the blooms of the marigold cultivars tested revealed that they were all carnation type. The RHS colour chart was used to identify the colour of the flower. Yellow 12B colour flowers are produced by Arka Bhanu (T_1), Yellow 5A flowers colour produced by Arka Abhi (T_3) and Yellow 15A flowers colour was observed in KAU M1 (T_7). In orange group, Orange N25A blooms may be found on Arka Subha (T_2) and Punjab Gainda 1 (T_5). Orange N25B blooms may be found in both BM-4 (T_6) and Pusa Narangi Gainda (T_9). Orange N25C blooms may be found in both Arka Vibha (T_4) and KAU M2 (T_8).

Flowers were physically compacted by pressing them with the palm, it was observed that all cultivars produced strong, loose and less compact flowers. Strong compact flowers were produced in genotypes Arka Bhanu (T_1) and Arka Abhi (T_3), however less compact flowers are found in both Arka Subha (T_2) and Arka Vibha (T_4), whereas loose compact flowers were produced in almost genotypes like, KAU M1 (T_7), KAU M2 (T_8), Punjab Gainda 1 (T_5), BM-4 (T_6) and Pusa Narangi Gainda (T_9).

Table 1: Mean performance of new genotypes of African marigold for shelf life (days) and total carotenoid content (mg/100 g)

Treatments	Shelf life (Days)	Total carotenoid content (mg/100 g)
T_1 - Arka Bhanu	4.51	233.97
T_2 - Arka Subha	5.52	756.50
T_3 - Arka Abhi	5.93	477.60
T_4 - Arka Vibha	6.40	282.40
T_5 - Punjab Gainda 1	5.37	325.80
T_6 - BM-4	6.37	275.40
T_7 - KAU M1	3.65	123.60
T_8 - KAU M2	4.37	189.45
T_9 - Pusa Narangi Gainda (Check)	3.51	425.60
SEm±	0.03	0.97
CD at 5%	0.10	2.96

Table 2: Colour intenisity of African marigold new genotypes flowers as per RHS colour chart

Treatments	Flower type	Flower colour (As per RHS colour chart)	Flower Compactness
T_1 - Arka Bhanu	Carnation type	Yellow 12B	+++
T_2 - Arka Subha	Carnation type	Orange N25A	++
T_3 - Arka Abhi	Carnation type	Yellow 5A	+++
T_4 - Arka Vibha	Carnation type	Orange N25C	++
T_5 – Punjab Gainda 1	Carnation type	Orange N25A	+
T_6 - BM-4	Carnation type	Orange N25B	+
T_7 - KAU M1	Carnation type	Yellow15A	+
T_8 - KAU M2	Carnation type	Orange N25C	+
T_9 - Pusa Narangi Gainda (Check)	Carnation type	Orange N25B	+

Symbols used in table indicates:
+++ Highly compact, ++ Less compact, + Loose

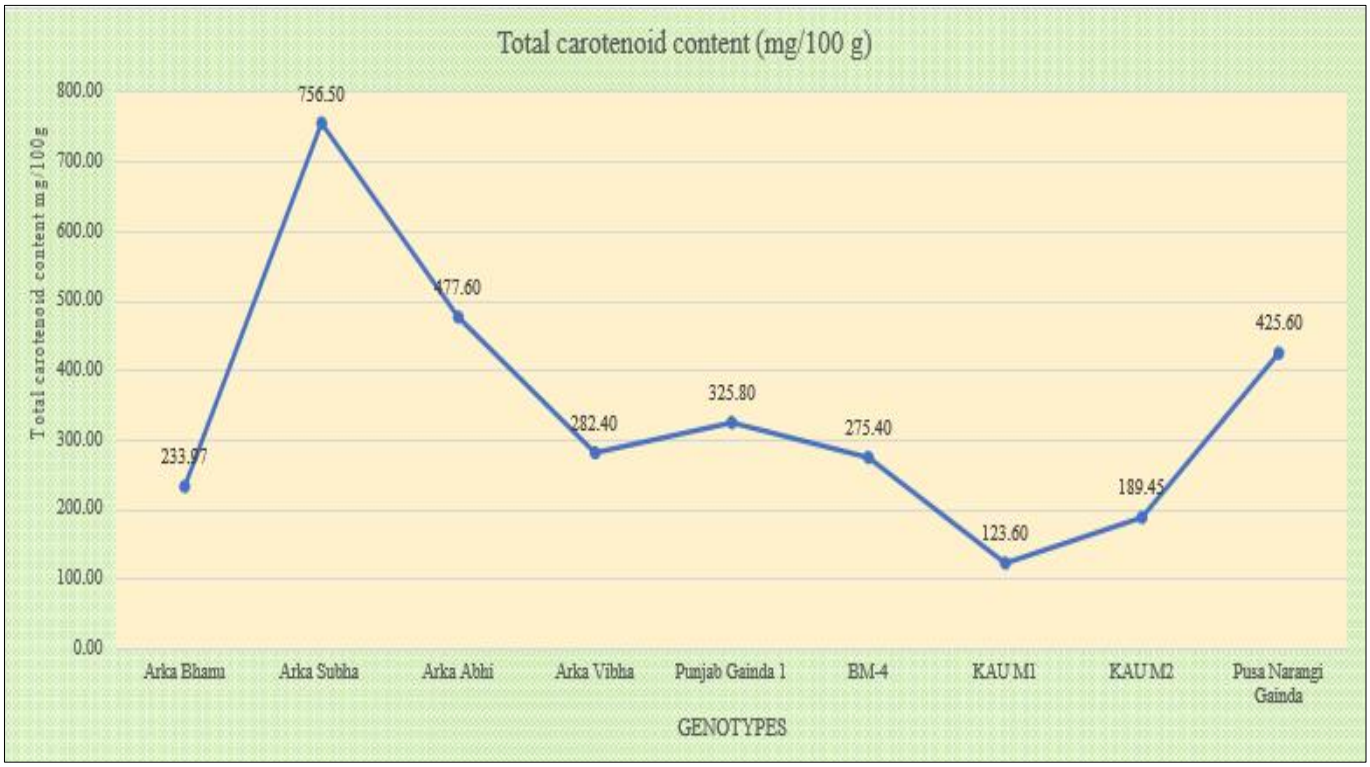

Fig 1: Mean performance of new genotypes of African marigold for total carotenoid content (mg/100 g)

Conclusions

This study highlighted the significant variations in shelf life, total carotenoid content, and color intensity among different African marigold genotypes. Arka Vibha demonstrated the longest shelf life, while Arka Subha exhibited the highest carotenoid content. The findings emphasize the importance of selecting suitable genotypes based on these quality parameters to meet the demands of the market and local cultural preferences. Further research and evaluation of genotypes under varying environmental conditions are crucial for the development and promotion of high-quality African marigold varieties.

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