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Diversity in Floret Color In Various Accessions of Five Different Species of Carthamus

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Abstract

The florets of Carthamus generally known as Safflower produce various types of pigments used in dye. A large variability was observed in floret color in 257 different accessions of 5 various species of Carthamus (C. glaucus, C. lanatus, C. oxycantha, C. palaestinus, C. tinctorius) and 1 subspecies of C. lanatus i.e. C. lanatus ssp turkestanicus. In the present work only eight shades white, purplish white, pale yellow, light yellow, yellow, base light orange tip yellow, base yellow and tips orange and reddish orange were observed. In majority of the accessions of different species the floral heads were of light yellow shade. In C. tinctorius about 26% accessions had light yellow florets. The other shades which were found to be common were reddish orange and yellow. The color of the florets might change to different degrees after fertilization in many accessions.

Keywords; Floret color diversity, various species, Carthamus.

INTRODUCTION

Latinized from the Arabic words "quartum" or "gurtum," which refer to the colour of the dye made from the flower heads, Carthamus L. is a member of the tribe cynareae (thistle), sub-family tubifloreae of the family Compositae. The only species of this genus that is grown commercially is C. tinctorius, more often known as safflower. As an affordable alternative to saffron, safflower flowers are often called "bastard saffron" and used in cooking on occasion. (Gerarde, 1957; Smith, 1996).

Carthamus originates from the Old World. Extending from China to the Mediterranean area, the Nile valley, and even Ethiopia, this variety of plant has been cultivated for generations. Colouring foodstuffs and garments was the primary function of this factory. (Dajue and Yunzhou, 1993; Dajue and Mundel, 1996). Carthamin, a red dye (FAO, 2016) and yellow dye (FAO, 2022), extracted from the flowers was in extensive use in the nineteenth century to color clothing. There is around 0.83 percent red pigment and 30 percent yellow pigment in safflower petals.

It was grown for the same use in Europe in the sixteenth century as far north as southern Germany (Reiff, 1546). Safflower has a long history of cultivation in India, with the brightly coloured florets and orange-red dye being the most popular uses, as well as the oil extracted from the seed. Rudometova et al. (2001) states that safflower red and yellow pigment is a wonderful, safe, natural pigment that may be utilised as a cosmetic and culinary colourant.

Though it wasn't until much later that this plant was cultivated for its oil; pre-Christian Mesopotamians knew it as edible oil (Weiss, 1971). India is one of the major producers of safflower along with U.S.A., Australia, Mexico and Spain. In India, its large-scale cultivation is confined to areas located between "latitudes of 14 and 22° North and longitudes 73.5° and 79° East. Over 98% area is concentrated in the states of Maharashtra (73%). Karnataka (23%) and Andhra Pradesh (2.8%)." Safflower is more or less day-neutral but thermo sensitive (Sreenivas, 2023).

In northern and peninsular regions, the ideal season for its commercial culture is winter (September or October to March or April). Safflower is more popular as a mixed or as an intercrop with other rabi crops (Sastry, 2022).

An additional usage for the dried safflower petals is in the form of a herbal tea (Landaua et al., 2004). The pigments are utilised in a wide range of products in numerous industries across numerous countries, including China and Japan. These include food dyes, coloured juice, candy, and meat and soybean products (Shouchun et al., 1993; Nagaraj et al., 2001; Zhaomu and Lijie, 2001); hair-cream, shampoo, face cream, and perfume (Hanania et al., 2004); lipstick (Darmstadt et al., 2002), rouge, bath soap, and high-quality egg cakes (Kim et al., 2002). Safflower petals have been shown to have a lot of medicinal and therapeutic values (Dajue, 1993; Yunzhou, 1997; Hanania et al., 2004; Lizhong, 1993; Kulkarni et al., 2001). The classification of the genus has been a matter of great dispute. The genus has about 34 species with varying chromosome number of 2n=20 to 2n=64 and has a wide range of adaptation. The objective of the present work was to work out the floret color diversity in various species as well as various varieties of Carthamus.

Materials and Methods

The phenotypic variability between the accessions belonging to the same and different species was critically evaluated using the vegetative, reproductive and yield related parameters of the adult plants. The seeds of 257 different accessions were procured from various countries (Table 1) and were sown in the month of October,2024 at the research field of Cytogenetics lab C.C.S. University. Meerut. The floral characteristics were measured in different accessions when the plants exhibited optimum bloom.

Table 1. List of various species of Carthamus

.S.No.	Species	Number of accessions	Country	Sources
01	*C. glaucus*	02	Lebanon, China	USDA, AICRPO
020	*C. lanatus*	08	E. Germany, Belgium, Portugal, Former USSR	AICRPO, USDA, NBPGR
03	*C. lanatus* ssp *turkestanicus*	05	Afghanistan	USDA, NBPGR
04	*C. oxycantha*	01	Former USSR	AICRPO
05	*C. palaestinus*	07	USA, Israel	AICRPO, NBPGR
06	*C. tinctorius*	234	Afghanistan, Canada, China, Czechoslovak ia, Ethiopia, Iran, Iraq, Jordan, Italy, Kazakhstan, Pakistan, Mexico, Poland, Portugal, Spain, Sudan, Syria, Turkey, USA, Uzbekistan, India	USDA, AICRPO, DOR, NBPGR, Self

Observations

The floral heads of the accessions of Carthamus differed in the color of the florets and in the number and morphology of the bracts. The color of the florets was showing significant variability and could be divided into 8 categories:

(1) White (fig. 1 a).

(2) Purplish white (fig. 1 b).

(3) Pale yellow (fig. 1 c).

(4) Light yellow (fig. 1 d).

(5) Yellow (fig. 1 e).

(6) Base light orange: tip yellow (fig. 2 a-d).

(7) Base yellow and tips orange (fig. 3 a. b) and

(8) Reddish orange (fig. 3 c. d).

Data related to the distribution of floret color pattern are given in table 2. Light yellow color of the florets was observed in nearly all species of Carthamus. Frequency distribution of the accessions of C. tinctorius showing different floret colors is shown in figure 5. About 26%

accessions of this species had light yellow florets. The color of the florets might change to different degrees after fertilization in many accessions. For instance, yellow florets after fertilization changed to orange color (fig. 4 a, b): while in several others the color remained the same (fig. 4 c, d). The graphical presentation of distribution of different floret color in C. tinctorius is shown in figure 5.

Table 2. Data showing floret color variation in various species of Carthamus

S.No.	Species	Floret colors
01	*C. glaucus*	Light yellow
02	*C. lanatus*	Light yellow, Yellow, Base yellow, Reddish orange
03	*C. lanatus* ssp *turkestanicus*	Light yellow, Yellow, Reddish orange
04	*C. oxycantha*	Yellow
05	*C. palaestinus*	Light yellow, Base light orange, Reddish orange
06	*C. tinctorius*	White, purplish white, pale yellow, light yellow, yellow, base light orange, base yellow, reddish orange

Table 3. Frequency distribution (in percent) of floret color in various species of Carthamus

S. No.	Species	No. of accessions	01	02	03	04	05	06	07	08
01	*C. glaucus*	02				100				
02	*C. lanatus*	08				25	25		25	25
03	*C. lanatus* ssp *turkestanicus*	05				33.33	33.33			33.33
04	*C. oxycantha*	01	100							
05	*C. palaestinus*	07				33.33		33.33		33.33
06	*C. tinctorius*	234	5.9	5.1	10.6	25.6	14.9	16.2	3.8	17.5

(1) White, (2) Purplish white, (3) Pale yellow, (4) Light yellow, (5) Yellow, (6) Base light orange: tip yellow, (7) Base yellow and tips orange and (8) Reddish orange.

Results and Discussions

The data showed that among five species of Carthamus light yellow color of the florets was very common. In C. glaucus both accessions possessed light yellow florets. In C. lanatus some variability was observed and four floret colors were found light yellow, yellow, florets with base yellow and tips orange and reddish orange. In one subspecies of C. lanatus turkestanicus three shades were observed light yellow, yellow and reddish orange. In one accession of C. oxycantha only white florets were found. In C. palaestinus three floret colors light yellow, floret with base light orange and tips yellow and reddish orange were observed. Amongst 234 accessions of C. tinctorius eight shades light yellow (26%), reddish orange (18%), base light orange with tips yellow (16%), yellow (15%), pale yellow (11%), white (6%), purplish white (5%) and base yellow with tips orange (4%) were observed.

Kupsow (1932) noted that the most usual floret colors in the species are yellow and orange, sometimes white or ivory, with deep red, which was common in Afghanistan and adjacent countries. In Japan, Nishikawa et al. (1957) correlated the floret color with the oil content of seeds. That type of correlation was not established during this work. Ashri and Knowles (1960) and Hanelt (1961) analyzed variability in floret color in quite detail in various species of Carthamus. Although, several shades of color were reported by these workers for the heads of different species of this genus, only eight shades could be presently observed. In majority of the accessions the floral heads were of light yellow shade. Whether the shades are dependent on the soil and other climatic conditions could not be ascertained presently. This requires a testing of the clones of the same plant in different environmental conditions that was not conducted during this study.

The survey of literature shows that a lot of work has been done on various aspects of the floret as the inheritance, correlation with oil and yield. It was found by http://www.ars-grin.gov/npgs/descriptors/safflower (2001) that the floret color in majority of accessions of Carthamus was orange, red or yellow. The inheritance of flower color and spininess in safflower has been worked out by Pahlavani et al. (2004). Ghorbani et al. (2015) worked on the optimization of extraction yield of carthamine and safflower yellow pigments from safflower (Carthamus tinctorious L.) under different treatments and solvent systems.

Gupta et al. (2020) has observed plant morphological variation in various species of Carthamus. Kim et al. (2020) worked out assessment of metabolic profiles in florets of

Carthamus species using Ultra-Performance Liquid Chromatography-Mass Spectrometry. In 2021 Gupta et al. also reported reproductive and yield related variations in different species of Carthamus. Erbaş and Mutlucan (2023) investigated flower yield and quality in different color safflower genotypes.

CONCLUSION

In the present study the floret color variation among five different species (C. glaucus, C. lanatus, C. lanatus ssp turkestanicus, C. oxycantha, C. palaestinus and C. tinctorius) and 257 accessions of Carthamus were worked out. The result showed that interspecific as well as intraspecific genetic diversity was present in accessions procured from different regions. Amongst all species light yellow color was dominating over other shades. In Carthams tinctorius where maximum accessions were available all eight shades were found. The floret color also changed with the maturity of flowering heads. The present investigation was just an attempt to find out the floret color diversity in the large Carthmaus germplasm available.

Fig. 1. Floret color white, purplish white, pale yellow, light yellow, yellow

Fig. 2. Base light orange: tip yellow

Fig. 3. a, b. Base yellow and tips orange c, d. Reddish orange

Fig. 4. a.b. Change in the color of the florets after fertilization, c. d. No change in the color of the florets after fertilization

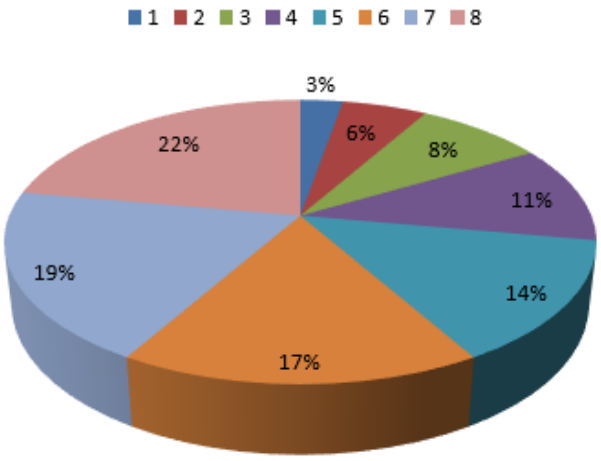

Fig. 5. Graphical representation of distribution of different floret colors (1 to 8) in C. tinctorius

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