



Study of seed related characteristics in different species of *Carthamus* L.

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ABSTRACT

In the present work two hundred and fifty seven accessions belonging to five species of *Carthamus* have been critically examined for seed characteristics seed color, pappus and number of ridges on seeds. Four shades of the colour namely: cream, dark cream, light brown and brown were available. Accessions of *C. glaucus*, *C. lanatus*, *C. oxycantha* and *C. palaestinus* were cream in colour except three accessions of *C. lanatus* out of which two had dark cream and one had brown coloured seeds. In *C. tinctorius* accessions, seeds having all the four shades were available but majority of them had cream (49%) or dark cream (37%) in colour. The accessions of *Carthamus* had seeds with as well as without pappus. In *C. glaucus* one out of two, in *C. lanatus* six out of thirteen, in *C. oxycantha* one, in *C. palaestinus* five out of seven, and in *C. tinctorius* one hundred seven out of two hundred thirty four possessed pappus. The pappus also varied in size as well as in colour. The seeds of all the accessions possessed 2-8 ridges on their outer surface. The accessions differed in the mean and range of ridges per seed. Most of the *C. tinctorius* accessions possessed 4 or > 4 ridges per seed. Very rarely less than 4 ridges were found. In case of the other species of *Carthamus* the number of ridges ranged from 2-7, with few accessions only, having < 4 mean number of ridges per seed.

KEYWORDS: seed characteristics, seed color, seed pappus, number of ridges, *Carthamus*.

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INTRODUCTION

Carthamus L. belongs to the tribe cynareae (thistle), sub-family tubifloreae of the family Asteraceae. *Carthamus* is the latinized version of the Arab word 'quartum' or 'gurtum', which alludes to the color of the dye, obtained from the flower heads. 'Usfar' is probably the origin of the English name 'safflower' via various written forms of 'affore', 'asfiore' and 'saffiore', to safflower. In ancient India, Sanskrit authors described the plant under the name 'kusumbha' from which the most common modern name of 'kusum' is derived. One of the species *C. tinctorius*, commonly called safflower, is the only cultivated species of this genus. *Carthamus* is a native of Old World. The main use of this plant was as a dye for food and clothing. The crop is mainly cultivated for its seeds, which yield a good quality oil, though at one time it used to be grown for extraction of a dye from its flowers. The seeds contain 24-36% oil [26, 27]. The important safflower growing countries are India, Mexico, U.S.A., Australia and Spain. In India, its large-scale cultivation is confined to areas as Maharashtra, Karnataka and Andhra Pradesh.

For centuries, safflower has been under cultivation in India either for its brilliantly colored florets and the orange-red dye or for oil from the seed. 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. Safflower also has a wide range of other medicinal uses [20-24].

The seeds are themselves edible and are eaten after roasting. The oil cake, particularly from decorticated seeds is used as a cattle feed. It contains about 40-45% protein. The cake obtained from undecorticated seeds is used as manure as it contains about 5% nitrogen, 1.44% phosphorus and 1.23% potash. The green safflower can be used as a green fodder for cattle. The genus *Carthamus* belongs to the family Asteraceae, therefore the seeds in its reality are achene type of fruits. For present description the achenes (fruits) shall be referred as seeds.

A perusal of literature shows that most of the work done in *Carthamus* has been done on improvement of the oil quality and quantity [15-17, 10] and the physical and mechanical properties of safflower seeds

Feizolahzadeh *et al.* [9] Delshad *et al.* [8] gave a comprehensive review on the traditional medicinal value of *Carthamus*. Latha and Prakash [21] also worked on the protein content in its seeds. Genetic analyses of the oil have also been done by some workers [16, 17, 10, 11, 20]. Gupta and Prakash [12], Aktas *et al.* [1], Baumler *et al.* [5-6], Kashaninejad and Rezagah [14], Tarighi *et al.* [24, 25], Seifi *et al.* [23] worked on the moisture content of the safflower seeds.

To the best of our knowledge the work undertaken in the present study has been done for the first time. In the present work three important characteristics of seeds have been taken for study, seed color, number of ridges on seeds and presence and absence of pappus on seeds.

MATERIAL AND METHODS

The genus *Carthamus* belongs to the family Asteraceae consequently, the seeds in reality are achene type of fruits though in this investigation the achene (fruits) shall be referred as seeds. Two hundred and fifty seven accessions belonging to five species of *Carthamus* were procured from various sources (table 1). Following seed related parameters were analysed for characterising the seeds.

- (a) Seed color
- (b) Number of ridges per seed and
- (c) Presence and absence of pappus



Fig. 1. Seed color shades in different accessions of *Carthamus*



Fig. 2. Color variation in seed pappus of different accessions of *Carthamus*



Fig. 3. Ridges on seeds different accessions of *Carthamus*

RESULTS AND DISCUSSION

Two hundred and fifty seven accessions belonging to five species of *Carthamus* have been critically examined for seed characteristics. The seeds of different accessions differed in their colour. Four shades of the colour namely: cream, dark cream, light brown and brown were available (fig. 1). Accessions of *C. glaucus*, *C. lanatus*, *C. oxycantha* and *C. palaestinus* were cream in colour except three accessions of *C. lanatus* out of which two had dark cream and one had brown coloured seeds. In *C. tinctorius* accessions, seeds having all the four shades were available. However, in majority of these accessions, the seeds were either cream (49%) or dark cream (37%) in colour but light brown and brown seeds were also not uncommon. The data related to the color of seeds in different species of *Carthamus* in percentage is shown in table 2.

The accessions of *Carthamus* had seeds with as well as without pappus. In *C. glaucus* one out of two, in *C. lanatus* six out of thirteen, in *C. oxycantha* one (only one accession available with us), in *C. palaestinus* five out of seven, and in *C. tinctorius* one hundred seven out of two hundred thirty four possessed pappus. The mean data related to percent presence and absence pappus is shown in table 3. The pappus when present varied in different accessions of *Carthamus* in size as well as in colour (fig. 2). The seeds of all the accessions possessed 2-8 ridges on their outer surface because of which they exhibited differences in external morphology (Fig. 3). The accessions differed in the mean and range of ridges per seed (table 4). For instance, majority of the *C. tinctorius* possessed 4 or > 4 ridges per seed. However, very rarely accessions with less than 4 ridges on their seeds were recorded too. In case of the other species of *Carthamus* the number of ridges ranged from 2-7, with few accessions only, having < 4 mean number of ridges per seed.

Seeds bear tiny dormant plants, the embryos, and the stored food required for their initial development. Under this condition, vital biochemical and physiological activities, essential for survival of embryo and other living portions of seeds, occur with minimal speed. During the present investigation, two hundred and fifty seven accessions belonging to five species of *Carthamus* were critically examined for seed characteristics. Since, the genus *Carthamus* belongs to the family Asteraceae, therefore the seed in its reality is achene type of fruits. The seeds of the *Carthamus* accessions differed from each other in characteristics like.

- (a) Color of seeds,
- (b) Number of ridges on seeds, and
- (c) Presence/absence of pappus.

The seeds possessed four shades, namely cream, dark cream, light brown and brown. The most common shade available was cream. However, the species-specific shade variability was not recorded. The same type of shades was available in different accessions belonging to the same species as well as to different species. Kursell [18] observed that the test a color in *Carthamus* might vary from dark or light brown. Through various shades of yellow to ivory or white. Ashri and Knowles [2], Hanelt [13] and [14] gave the description of seed color in several species of this genus *Carthamus*. However, their findings differed somewhat from the present findings. For instance, these workers reported grayish-brown and black colored seeds in *C. glaucus*, a range of colors from yellow-white to gray-brown in *C. lanatus*, shades varying between bright brown to black in *C. oxycantha*, bright brown seeds in *C. palaestinus* and only white colored seeds in *C. tinctorius*. During this study, only cream-colored seeds were available in *C. glaucus*, *C. oxycantha* and *C. palaestinus*. The color of the seeds of *C. lanatus* was observed to vary from buff to brown and sometimes dark brown [14] that was also noticed currently. Several shades of the color were also available in the seeds of the accessions of *C. tinctorius*. Rubis [22] worked out the anatomy of the testa and reported that the color variation could be because of the differential proportion of white sclerenchymatous layers and phytomelanin layers. He further reported that the absence of the melanin layer in the pericarp of the seed was due to a single recessive gene. Bassiri and Kheradnam [4] found the relationship between seed color and viability, germination and seedling growth in wild safflower ecotypes. However, such a correlation was presently not worked out.

Number of ridges in *C. glaucus*, *C. lanatus*, *C. oxycantha*, *C. palaestinus* and *C. tinctorius* varied from 4-6, 3-6, 3-4, 2-7, and 2-8 respectively. However, Ashri and Knowles [2] and Hanelt [13] reported only four ridges in different species of this genus. In that regard, the present observation related to number of ridges per seed is new information. Distribution patterns and dimensions of pappus were found to be a significant attribute of *Carthamus* seeds. During this study, the pappus was observed in seeds of only one accession of *C. glaucus*, six accessions of *C. lanatus*, one accession of *C. oxycantha*, five accessions of *C. palaestinus* and one hundred and seven accessions of *C. tinctorius*. Other workers too, studied the details of pappus. For instance, Claassen [7] found that one major gene with some modifiers determines the degree of the presence or absence of pappus. Ashri and Effron [1] reported that the presence of pappus was controlled by dominant locus over absence of pappus in safflower. Kotecha and Zimmerman [19] also

worked out the inheritance of seed pappus in a cross between one selection of *C. palaestinus* and three cultivars of *C. tinctorius*. The study indicated that the pappus inheritance was controlled by at least two loci and the heritability estimates for pappus was high. The range of the length of pappus in *C. leucocaulos*, *C. baeticus* and *C. lanatus*, varied from 5-7 mm, 8-10 mm and 10-13 mm respectively [13].

Table 1. Details of *Carthamus* accessions procured from various sources

S.No.	Species	Number of accessions	Sources
1	<i>C. glaucus</i>	02	USDA, AICRPO
2	<i>C. lanatus</i>	13	NBPGR, USDA
3	<i>C. oxycantha</i>	01	AICRPO
4	<i>C. palaestinus</i>	07	AICRPO, NBPGR
5	<i>C. tinctorius</i>	234	AICRPO, NBPGR, DOR

USDA = United States Department of Agriculture

AICRPO = All India Coordinated Research Project on Oilseeds

NBPGR = National Bureau of Plant Genetic Resources

DOR = Directorate of Oil Research

Table 2. Data showing percent accessions showing various seed colours of different *Carthamus* species.

S.No.	Species	Seed Color Shades			
		1	2	3	4
1	<i>C. glaucus</i>	100	-	-	-
2	<i>C. lanatus</i>	77	15	-	0.1
3	<i>C. oxycantha</i>	100	-	-	-
4	<i>C. palaestinus</i>	100	-	-	-
5	<i>C. tinctorius</i>	48.59	36.98	9.03	6.02

1= cream, 2= dark cream, 3= light brown, 4= dark brown

Table 3. Data showing percent accessions showing presence (+) and absence (-) of pappus in seeds of different *Carthamus* species.

S.No.	Species	Presence of Pappus	
		+	-
1	<i>C. glaucus</i>	50	50
2	<i>C. lanatus</i>	46	54
3	<i>C. oxycantha</i>	100	-
4	<i>C. palaestinus</i>	71	29
5	<i>C. tinctorius</i>	46	54

Table 4. Mean data of number of ridges in different species of *Carthamus*.

S.No.	Species	Mean	±	SE	Range		
1	<i>C. glaucus</i>	4.27	±	0.09	4	-	6
2	<i>C. lanatus</i>	4.17	±	0.09	3	-	6
3	<i>C. oxycantha</i>	3.9	±	0.05	3	-	4
4	<i>C. palaestinus</i>	4.1	±	0.12	2	-	7
5	<i>C. tinctorius</i>	4.3	±	0.09	2	-	7

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