Chapter 15

Investigation of Changes in Physical Properties of Some Safflower (*Carthamus tinctorius* L.) Cultivars After Film Coating Application

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INTRODUCTION

Safflower, a valuable oil plant with an annual herbaceous structure, has been cultivated for about 3000 years (Koç et al., 2017; Culpan and Arslan, 2018; Baydar and Erbaş, 2020). It has a high tolerance to conditions such as drought and low temperature, thanks to its behavior in consumption of water and nutrients in the soil depending on its root structure (Uysal et al., 2006; Dumanoğlu, 2022b). Due to these features, safflower is important in making use of fallow lands, controlling erosion control, and expanding cultivation areas (Baydar and Erbaş, 2020; Esendal, 1981; Bayraktar, 1991; Geçit et al., 2018; Köse et al., 2021). Safflower (Carthamus tinctorius L.) is sown in two seasons, summer and winter. Depending on the irrigation conditions, it can be thorny or thornless and has yellow, white, red, and orange flowers with a height of 50-150 cm. Its seeds can be white, brown, striped white, and rarely black (Culpan and Arslan, 2018; Nacar et al., 2016; Toprak and Tunçtürk, 2018). The flowers and seeds of the safflower plant are used in many sectors (Dumanoğlu, 2022a). Safflower oil is used in biodiesel production as well as in the food, medicine, textile, and paint industries (Kırıcı, 1998; Yılmaz and Tunçtürk, 2018). It is also used as animal feed and ornamental, medicinal, and aromatic plant (Koç and Güneş, 2021). The unsaturated fatty acids (oleic acid and linoleic acid) account for about 90% of the total fatty acid content of the safflower seed. It contains 32-34% carbohydrates, 14-15% protein, 5-8% moisture, and 2-7% ash (Weiss, 2000; Çosge et al., 2007; Kalafat et al., 2009).

Since safflower (Carthamus tinctorius L.) is economically valuable and durable, mechanization trials and breeding studies have been carried out in order to expand its cultivation areas. In these studies, it was aimed to place the seeds in the soil with the least product loss by choosing the appropriate tools, machines, and systems for the physical properties of the seeds. In addition, in breeding studies, the characteristics of seeds are important in the development of new varieties.

Seed technologies are used for the purposes of increasing the resistance of seeds to ecological conditions and increasing the planting opportunities. Researches are being carried out to increase seed quality through methods such as the use of plant nutrients, film coating, and pelleting.

In this study, the seeds of different safflower (Carthamus tinctorius) cultivars were examined separately under two groups, control and film-coated, and some physical properties of the seeds were determined.
MATERIAL AND METHOD

This study was carried out in the laboratories of the departments of Biosystem Engineering and Field Crops, Faculty of Agriculture, Bingöl University in 2021. In this study, the seeds of four different safflower (Carthamus tinctorius L.) cultivars (Balcı, Dinçer, Yektay, and Yenice) were used as plant material. The safflower seeds were obtained from the Transitional Zone Agricultural Research Institute, Ministry of Agriculture and Forestry, Republic of Türkiye. The seeds were examined in two groups, control group and film-coated group. SPSS v.22 statistical package was used to analyze the data, and TUKEY test was used to determine the differences. The statistical significance was set at p<0.05.

In the study, a water-based polymeric material from a commercially sold brand in the market was used in the film coating application. The safflower seeds were film coated (single layer) by spraying and then dried at room temperature (approximately 24 °C) in a moisture-free, dry, and dark environment for 24 hours (ISTA, 2007).

Table 1: Classification of the seeds by their geometric characteristics and shapes

<table>
<thead>
<tr>
<th>Geometric characteristics</th>
<th>Grain width/Grain length (b/a) (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long</td>
<td>&lt; 0.6</td>
</tr>
<tr>
<td>Medium</td>
<td>0.6 – 0.7</td>
</tr>
<tr>
<td>Short</td>
<td>&gt; 0.7</td>
</tr>
<tr>
<td>Shapes</td>
<td>Length (a), Width (b), Thickness (c) (mm)</td>
</tr>
<tr>
<td>Round</td>
<td>a ≈ b ≈ c</td>
</tr>
<tr>
<td>Oval</td>
<td>a/3 &lt; b ≈ c</td>
</tr>
<tr>
<td>Long</td>
<td>c &lt; b &lt; a/3</td>
</tr>
</tbody>
</table>

Ref: Yaşcıoğlu, 2015

The length (mm), width (mm), and surface area (mm²) of the seeds were measured using a stereo microscope (Nikon SMZ 745T) (Dumanoğlu and Geren, 2020; Dumanoğlu et al., 2021). The obtained data were evaluated according to the seed classification criteria specified in Table 1. The mean arithmetic diameter of the seeds (mm) ((L+W)/2), their mean geometric diameter (mm) ((L*D^2)^(1/3)) and sphericity (D_w/L) [L: Seed length (mm) W: Seed width (mm)] were calculated using the data (Mohsenin, 1970; Alayunt, 2000; Kara, 2012; 2017). In addition, 1000-grain weight was measured in triplicate randomly for both groups (Dumanoğlu and Öztürk, 2021; Ozturk ve Dumanoğlu, 2021).
RESULTS AND DISCUSSION

We examined some physical properties of four different safflower (Carthamus tinctorius L.) cultivars under two separate groups (control and film coated) and found that, in the control group, the seeds of the variety Balcı had the highest length (7.599 mm) and those of the variety Yenice had the lowest length (6.502 mm); the seeds of the variety Dinçer had the highest width (3.721 mm) and those of the variety Yektay had the lowest width (3.508 mm); and the seeds of the variety Balcı had the highest surface area (22.027 mm²) and those of the variety Yenice had the lowest surface area (18.792 mm²).

The average arithmetic diameter, average geometric diameter, and sphericity of the seeds were calculated using these values and the above mentioned equations. It was found that, in the control group, the seeds of the variety Balcı had the highest mean arithmetic diameter (5.572 mm) and those of the variety Yenice had the lowest (5.062 mm); the seeds of the variety Balcı had the highest mean geometric diameter (79.738 mm) and those of the variety Yenice had the lowest (56.458 mm); and the seeds of the variety Balcı had the highest sphericity (10.700) and those of the variety Yenice had the lowest (8.589). As for the thousand grain weights of the control group, the variety Balcı was found to have the highest 1000 grain weight (40.434 g) and the variety Yenice had the lowest (34.843 g) (Table 2).

As for the film-coated group of four different safflower varieties, it was found that the seeds of the variety Balcı had the highest length (7.427 mm) and those of the variety Yektay had the lowest length (6.452 mm); the seeds of the variety Yektay had the highest width (3.661 mm) and the seeds of the variety Yenice had the lowest width (3.503 mm); and the seeds of the variety Yenice had the highest surface area (21.248 mm²) and those of the variety Yektay had the lowest surface area (18.709 mm²).

It was found that, in the film coated safflower cultivars, the seeds of the variety Yenice had the highest mean arithmetic diameter (5.480mm) and those of the variety Yektay had the lowest (5.056 mm); the seeds of the variety Yenice had the highest mean geometric diameter (76.184 mm) and those of the variety Yenice had the lowest (55.729 mm); and the seeds of the variety Yenice had the highest sphericity (10.082) and those of the variety Yektay had the lowest (8.561). In the film-coated group, the variety Balcı was found to have the highest 1000 grain weight (40.562 g) and the variety Yenice had the lowest (35.645 g) (Table 2). Based on these results, it can be asserted that all the safflower seeds in the control group and the film-coated group had a long and oval seed structure.
As a result of the measurement and calculation processes, it was found that the safflower (*Carthamus tinctorius* L.) varieties in the control and film coated groups had similar values in all parameters. This is primarily due to the application of a single layer film coating. There was not much difference between the coated and uncoated seeds in terms of size, and the film material did not cover the seed like a barrier. This is extremely important for germination and emergence performances. In addition, it should be noted that the seeds randomly selected for film coating were slightly smaller than those in the control group.

The thousand grain weights found in this study were in agreement with those reported in previous studies. Koc et al. (2017) examined the yield components of five safflower lines (106-2, 11-1, 77-1-d, 89-1-c, BDYAS-9) developed by selection between 2015 and 2016 in Konya and some standard safflower varieties (Göktürk, Balcı, Linas, Olas, Dinçer) and reported that the 1000 grain weights found in this study were in agreement with those reported in previous studies. Koc et al. (2017) examined the yield components of five safflower lines (106-2, 11-1, 77-1-d, 89-1-c, BDYAS-9) developed by selection between 2015 and 2016 in Konya and some standard safflower varieties (Göktürk, Balcı, Linas, Olas, Dinçer) and reported that the 1000 grain

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**Table 2. Some physical characteristics of the seeds of the safflower varieties**

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Surface area (mm²)</th>
<th>Avg. Arith. Diameter (mm)</th>
<th>Avg. Geo. Diameter (mm)</th>
<th>Sphericity</th>
<th>Thousand grain weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balcı</td>
<td>7.599a</td>
<td>3.545b</td>
<td>22.027a</td>
<td>5.572a</td>
<td>79.738a</td>
<td>10.70a</td>
<td>40.434</td>
</tr>
<tr>
<td>Dinçer</td>
<td>6.767ab</td>
<td>3.721a</td>
<td>20.485bc</td>
<td>5.244b</td>
<td>62.876b</td>
<td>9.209b</td>
<td>38.692</td>
</tr>
<tr>
<td>Yektay</td>
<td>7.460a</td>
<td>3.508b</td>
<td>21.247ab</td>
<td>5.479a</td>
<td>75.955a</td>
<td>10.072a</td>
<td>38.473</td>
</tr>
<tr>
<td>Yenice</td>
<td>6.502cd</td>
<td>3.622c</td>
<td>18.792d</td>
<td>5.062c</td>
<td>56.458ad</td>
<td>8.589c</td>
<td>34.843</td>
</tr>
<tr>
<td>Avg.</td>
<td>7.082</td>
<td>3.599</td>
<td>20.638</td>
<td>5.339</td>
<td>68.757</td>
<td>9.643</td>
<td>38.111</td>
</tr>
<tr>
<td>Stdv.</td>
<td>0.531</td>
<td>0.094</td>
<td>1.382</td>
<td>0.231</td>
<td>10.928</td>
<td>0.931</td>
<td>2.348</td>
</tr>
<tr>
<td>Film coated Balcı</td>
<td>7.427a</td>
<td>3.536b</td>
<td>21.151ab</td>
<td>5.482a</td>
<td>75.705a</td>
<td>10.05a</td>
<td>40.562</td>
</tr>
<tr>
<td>Film coated Dinçer</td>
<td>6.702bc</td>
<td>3.643a</td>
<td>19.758cd</td>
<td>5.173bc</td>
<td>60.491bc</td>
<td>8.959bc</td>
<td>39.456</td>
</tr>
<tr>
<td>Film coated Yektay</td>
<td>6.452a</td>
<td>3.661b</td>
<td>18.709bc</td>
<td>5.056a</td>
<td>55.729a</td>
<td>8.561a</td>
<td>38.803</td>
</tr>
<tr>
<td>Film coated Yenice</td>
<td>7.458d</td>
<td>3.503c</td>
<td>21.248d</td>
<td>5.480c</td>
<td>76.184d</td>
<td>10.082c</td>
<td>35.645</td>
</tr>
<tr>
<td>Avg.</td>
<td>7.010</td>
<td>3.586</td>
<td>20.217</td>
<td>5.298</td>
<td>67.027</td>
<td>9.419</td>
<td>38.617</td>
</tr>
<tr>
<td>Stdv.</td>
<td>0.510</td>
<td>0.078</td>
<td>1.214</td>
<td>0.217</td>
<td>10.480</td>
<td>0.778</td>
<td>2.110</td>
</tr>
</tbody>
</table>
weights of the varieties ranged from 36.5 g to 43 g. On the other hand, in their study, Geçit et al. (2018) reported that the safflower varieties had a 1000 grain weight of 30-45 g. The 1000 grain weights of the safflower cultivars examined in the present study were similar to those reported in these studies.

In this study, some physical properties of four different registered safflower (Carthamus tinctorius L.) cultivars were investigated. The safflower seeds were also coated using a film coating material in order to improve their properties and quality, and the film coated seeds were compared with those in the control group. Measurement and calculation processes, which form the basis for mechanization and breeding research, were carried out in this study. Based on the results of the study, it can be asserted that the variety Balcı in the control group and the variety Yenice in the film coated group came to the fore. This study is important in that it will form a basis for future research on seeds of oil plants.

**Acknowledgement**

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References


