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QUALITY DETERMINATION IN CONFECTIONERY SUNFLOWER

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The situation of confectionery sunflower in Turkey

- Sunflower is produced mostly for oil type in Turkey, but it is cultivated also for confectionery which is the most consumed snack among others such as pumpkin seed, peanut, pistachio, etc. in Turkey.
- Turkey confectionery sunflower planted areas are about 80-100 thousand ha area and seed production around 200 thousand tons.
- Local populations such as İnegöl Alacası (OP), Denizli Beyazı (OP) etc. are generally cultivated in Turkey, hybrid varieties with high yield, high quality, homogeneous and coarse seeds should definitely take place in Turkish production compared to these local varieties.



The situation of confectionery sunflower in Turkey

- Local varieties, in general, have low yields and low homogeneity.
- Turkey imports around 100 million dollars every year from China. These imported snack products are preferred by consumers, especially due to their taste.
- These Turkey's import from China, large, white stripes and the black grains has increased gradually, the demand for domestic white varieties has decreased considerably in the last few years.



The situation of confectionery sunflower in Turkey

- Turkey is one of the countries where sunflower seeds are consumed the most in terms of confectionery consumption. It is also a product that is added to many snacks.
- In Turkey, around 700 industrial companies operate in the snack sector, and the size of the sector where the products are delivered to consumers with approximately 7-8,000 retail sales points is over 1 billion dollars.





S 400 TG



METİNBEY



AHMETBEY



MURATBEY

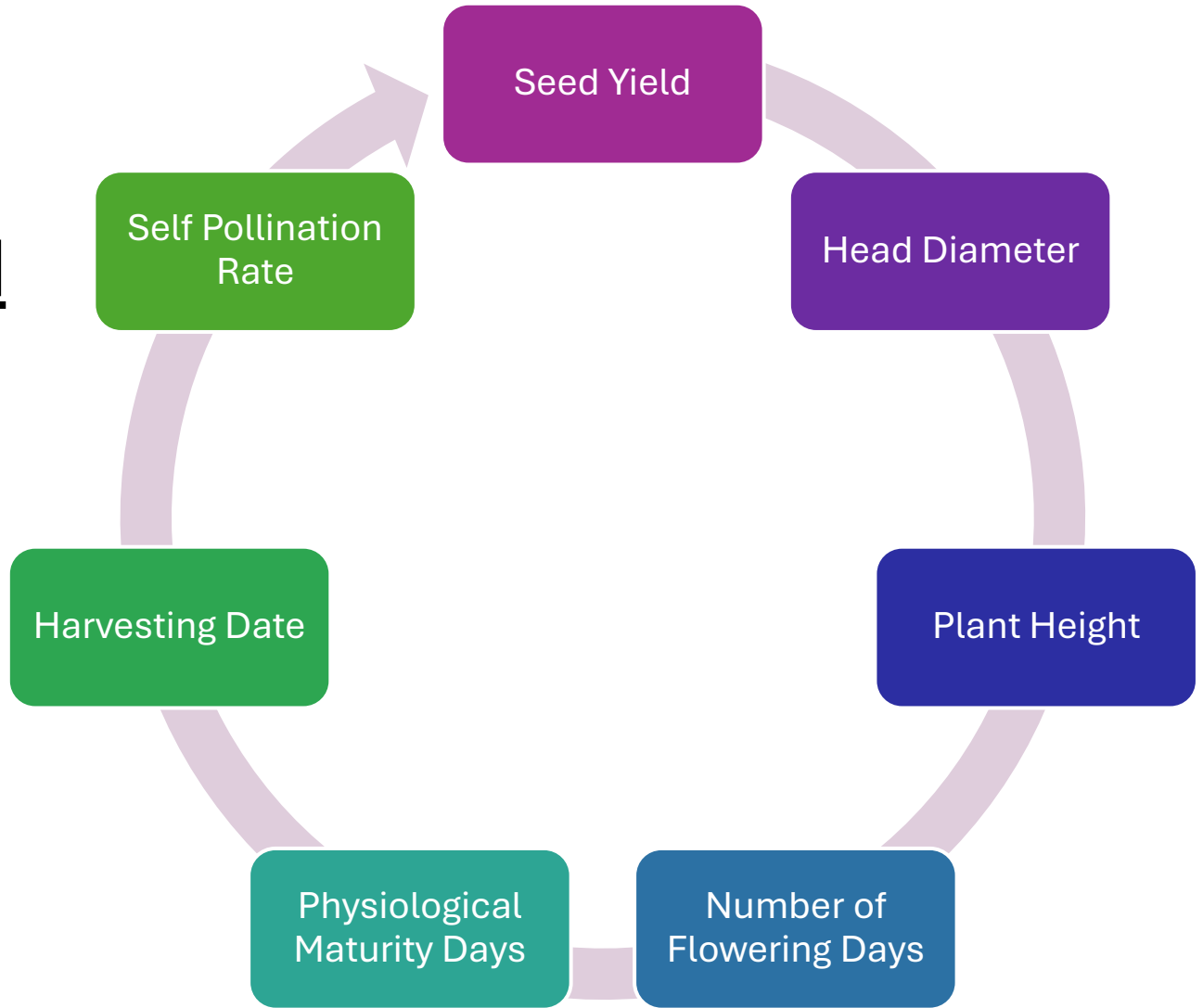
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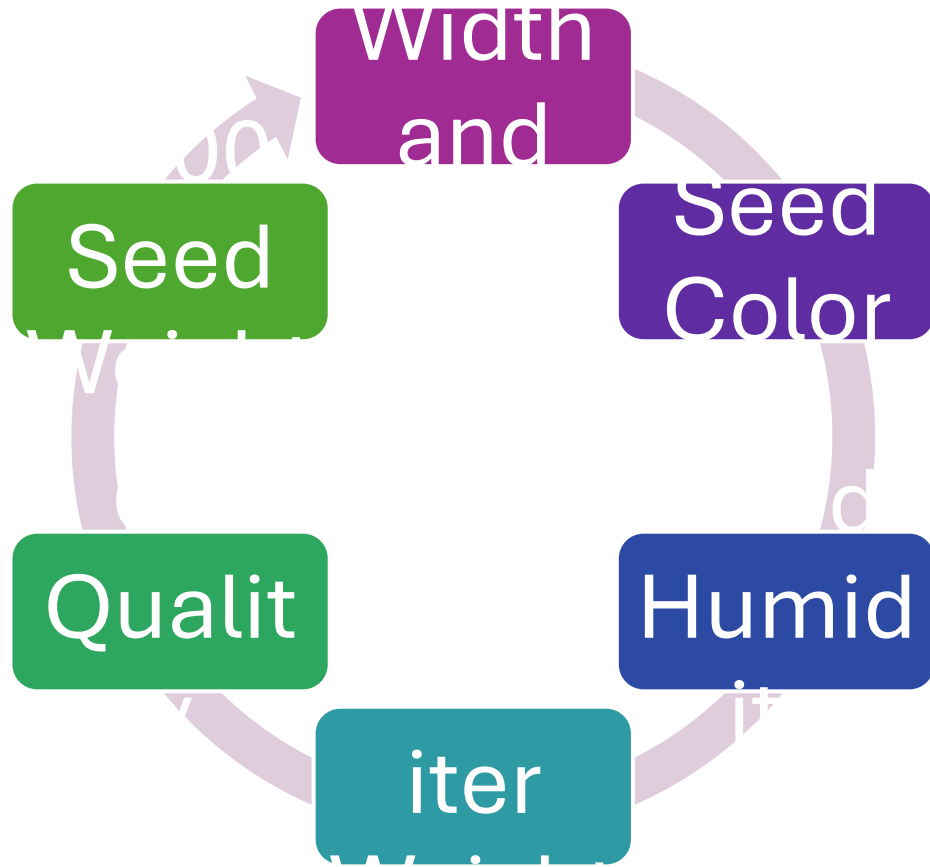
Purpose of the study

- The quality of confectionery sunflower is primarily related to its fatty acid composition, in other words its variability of fatty acid content and its susceptibility to oxidation.
- For that reason, morphological characteristics and chemical analyzes of confectionery sunflower comparisons were made between the samples.
- Study goal is to **examine the traits affecting confectionery sunflower quality and determining the taste**
- In the study, domestic hybrids developed by TRAGEN Arge Co., located in Trakya Technopark, the white-striped Inegöl Alaca which are currently planted, and the black colored varieties imported from China which are demanded in recent years, were be used as materials in the study.
- **18 Local Hybrid Candidate, 3 Imported Chinese Hybrid, 4 Control**

Material and Method



Material
and
Method



Material and Method





1- SEED YIELD

In the Planted Area Yield Trials, the middle two rows from the four rows in each iteration were harvested by hand. The blended grains were cleaned and weighed. At the time of weighing, the moisture content in the grain was determined with a moisture measuring device, and the yields were calculated according to 10% humidity, and the parcel yield and decare yield were found.

2-HEAD DIAMETER

In the physiological maturity period (R-6), it was determined by measuring the diameters of the heads of 5 plants in each plot.

3-PLANT HEIGHT

In the physiological maturity period (R-6), it was found by measuring the distance from the root collar on the soil surface of 5 plants in each plot to the stalk where the table is attached.

4-NUMBER OF FLOWERING DAYS

It is the time when the plants in each plot reach the 50% flowering (R.5.5) stage from emergence. By observing the condition of all the plants in the plot, the number of days when almost all of the plants reached this stage was determined.



5-PHYSIOLOGICAL MATURITY DAYS

It is the time when the plants in each plot reach the physiological maturity (R.9) from the exit from the soil. The number of days when almost all of the plants in the plot reach this stage has been determined.

6-HARVESTING DATE

It is the period when the humidity content of the seeds is around 15-16% and more than 50% of the head turns brown.



7-SELF POLINATION RATE

The varieties were classified according to the ratio of empty seeds above 5 90%, 4 80%, 3 70% and 2 60%, 1 less than 50% by examining the empty seed ratio from the edge to the inside on the head.





8-SEED WIDTH AND LENGTH

It was found by measuring the width and length of the varieties with the caliper after the harvest.

9-SEED COLUR

The seed color of the samples was determined according to the RHS color scale.

10-SEED HUMIDITY

After harvesting, the moisture content of the seed samples of each parcel was determined with a moisture measuring device.

11-HECTOLITER WEIGHT

After harvesting, the seeds of each parcel were determined with a hectoliter measuring device.

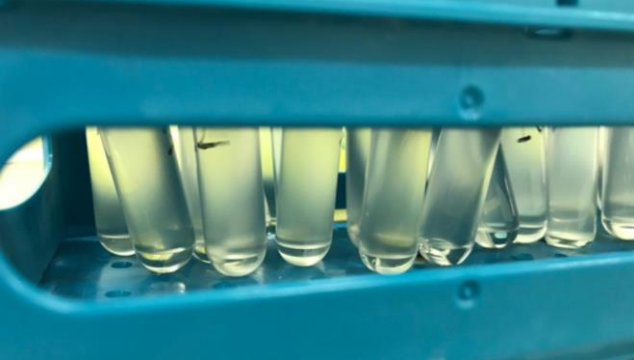
12-OIL QUALITY

The oil ratios of the varieties were measured with an NMR device.

13-1000 SEED WEIGHT

The samples of each parcel were determined using a counting machines.



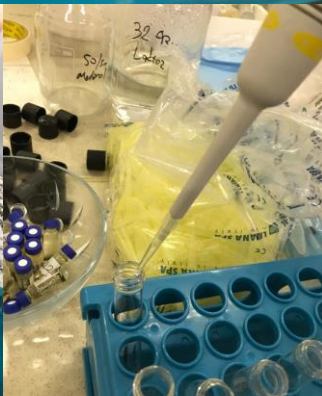


14-ROASTING SAMPLES

Sunflower seeds were roasted in a commercial roaster at 145 °C for 30 minutes (Guo et al., 2019). Analyses were carried out comparatively in raw and roasted samples.

15-DRY MATTER & WATER ACTIVITY

The dry matter content of sunflower seeds was determined based on the method applied by Kashaninejad et al. (2006). The moisture content was determined by placing the homogenized samples in approximately 4-5 grams of petri and drying them at 105 °C until they reached constant weighing. The water activity of the samples was determined by the Aqualab 4TE device.



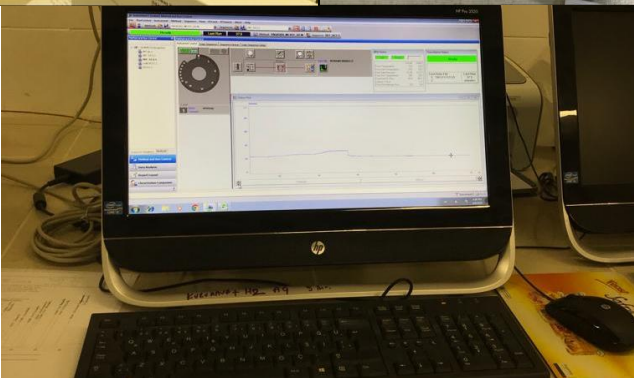
16-pH ANALYSIS

After the unshelled kernel samples were ground, 9 mL of pure water was added to 1 gram of sample and homogenized. The pH values of the obtained solutions were determined by measuring with a pH meter (Mettler-Toledo).



17-TOTAL AMOUNT OF PHENOLIC SUBSTANCES

The amount of phenolic substances in the samples was determined by spectrophotometer (UV1601, Shimadzu) according to the Folin-Ciocalteu colorimetric method. 1 gram was taken from the ground unshelled sunflower seed samples, 10 mL of hexane and 12 mL of methanol-water (60:40 V/V) were added to it, waited for 30 minutes and phenolic minerals were extracted. The sample was then separated from the phases by passing it through a coarse filter and centrifuged for 10 min at 3500 rpm of the filtrate. Methanol phase was taken and Folin-Ciocalteu solution and doumus sadium carbonate solution were added and the total phenolic substance was measured spectrophotometrically. The total amount of phenolic substances in the samples was determined according to the gallic acid standard curve (Karamac et al., 2012).





18-PROTEIN ANALYSIS

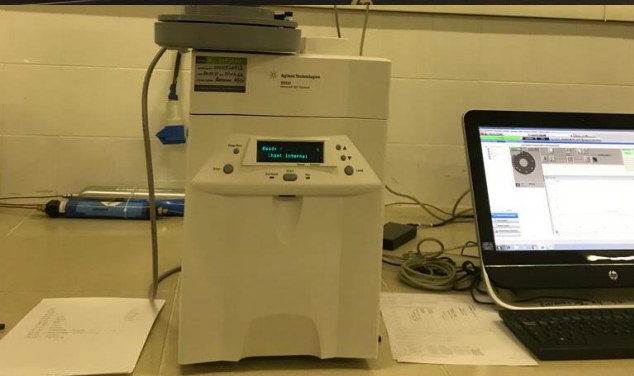
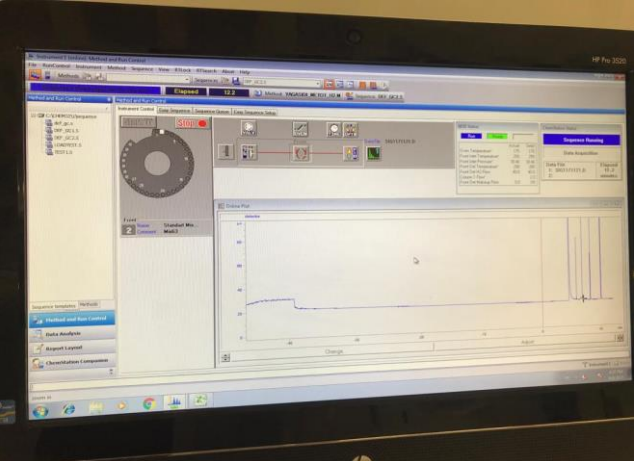
The amount of protein in unshelled sunflower seed samples was determined by the Kjeldahl method (Akgün, 2017).

19-ELEMENTAL CONTENT ANALYSIS

The elemental content of sunflower seeds (Ag, Ca, Cu, Fe, Mg, Mn, Na, Zn, P, Se, Cr and Pb) was determined by the Agilent 7700 ICP-MS device. Unshelled sunflower seeds (1 g) were first burned in a microwave (CEM, MARS6) burning device using nitric acid. The elemental substance content in the burned samples was determined by the ICP-MS device and their concentrations were calculated according to standard curves (Karlsson et al., 2015).

20-DETERMINATION OF OIL AMOUNT & FATTY ACIDS COMPOSITION

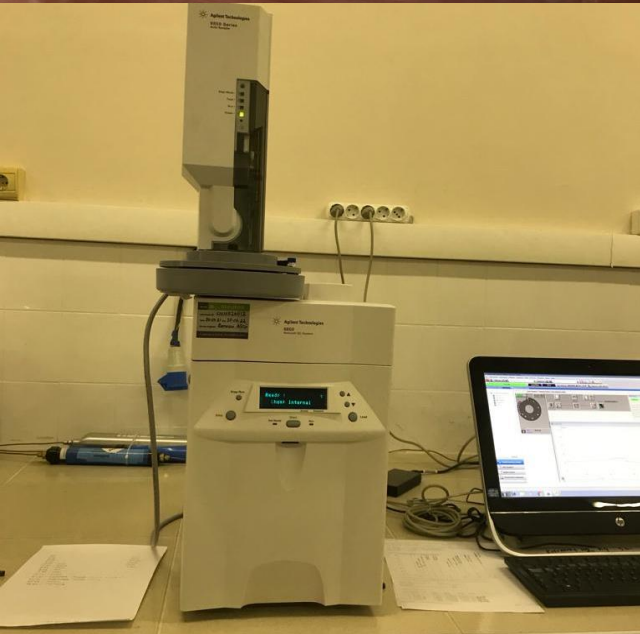
The fatty acid profiles of the samples were determined according to Ayyıldız et al. (2015) with GC-FID (Agilent 6850) device. 0.1 g of the extracted fatty acids was taken and 10 mL of hexane was added to it. Then, KOH(2N) solution was added in 100 μ L of methanol and the samples were mixed for 30 s and centrifuged for 5 min at 2500 g. GC FID method was performed according to Zhu et al. (2015).





21-COLOR ANALYSIS

Color analysis of sunflower kernels was measured according to CIE L*a*b* scale using Minolta CM-5 color measuring device. After the shells of the sunflower were peeled, they were taken to a petri dish for color measurement (Mosayebi et al., 2018).



22-SENSORY ANALYSIS

Sensory analysis of the samples (appearance, hardness, taste, aroma and total acceptability) was determined using a 5-point hedonic scale. Sensory analyses were carried out with 20 participants and samples (20 g) were presented to the panelists in a white dish (Mosayebi et al., 2018).



23-AROMA ANALYSIS

According to Guo et al. (2019), the aroma profiles of the samples were determined by GC-MS (Agilent 7890) device using the SPME method. The mass spectra obtained as a result of the analysis were defined using the NIST library.

24-STATISTICAL ANALYSIS

JUMP and SPSS statistical package programs were used in the statistical analysis of the data. The data were statistically compared with the LSD Multiple Comparison Test ($p < 0.05$)).



**SAMPLE
S**

#	Name	#	Name
1	22-ÇRZ-VD-113	13	22-ÇRZ-VD-105
2	22-ÇRZ-VD-116	14	22-ÇRZ-VD-111
3	22-ÇRZ-VD-213	15	22-ÇRZ-VD-109
4	22-ÇRZ-GB-30	16	STRIPI (Chinese Hybrid)
5	22-ÇRZ-GB-19	17	DENIZLI BEYAZI(C)
6	22-ÇRZ-GB-24	18	AHMETBEY (C)
7	22-ÇRZ-VD-318	19	IMI-ÇRZ-VD-6
8	22-ÇRZ-VD-103	20	G1 (Chinese Hybrid)
9	22-ÇRZ-VD-101	21	TG400 (C)
10	22-ÇRZ-VD-110	22	AFFAN(Chinese Hybrid)
11	22-ÇRZ-VD-112	23	IMI-ÇRZ-VD-3
12	22-ÇRZ-VD-104	24	IMI-ÇRZ-VD-16
		25	PALANCI 1 (C)



RESULTS

	NAME	Seed Color	Yield Kg / Da	Flowering Day	Physiological Maturity Days
	22-ÇRZ-VD-113	White Stripes in Black	316,7	72	110
	22-ÇRZ-VD-116	White Stripes in Black	361,2	70	105
	22-ÇRZ-VD-213	White	333,0	70	104
	22-ÇRZ-GB-30	White Stripes in Black	205,2	70	107
	22-ÇRZ-GB-19	White Stripes in Black	256,6	70	109
	22-ÇRZ-GB-24	White	287,0	69	105
	22-ÇRZ-VD-318	White Stripes in Black	343,4	72	110
	22-ÇRZ-VD-103	White Stripes in Black	299,8	72	107
	22-ÇRZ-VD-101	White Stripes in Black	333,2	71	107
	22-ÇRZ-VD-110	White Stripes in Black	289,5	71	105
	22-ÇRZ-VD-112	White	305,0	71	107
	22-ÇRZ-VD-104	White Stripes in Black	314,0	73	110
	22-ÇRZ-VD-105	White Stripes in Black	216,1	72	104
	22-ÇRZ-VD-111	White	228,5	71	105
	22-ÇRZ-VD-109	White Stripes in Black	260,7	72	105
	STRİPİ (Chinese Hybrid)	White Stripes in Black	300,0	70	105
	DENİZLİ BEYAZI (C)	White	171,5	71	105
	AHMETBEY (C)	White/Black Stripes	199,0	69	105
	İMİ-ÇRZ-VD-6	White/Black Stripes	272,0	71	105
	G1 (Chinese Hybrid)	White Stripes in Black	321,8	71	106
	TG400 (C)	White/Black Stripes	369,0	70	104
	AFFAN (Chinese Hybrid)	White Stripes in Black	333,0	70	104
	İMİ-ÇRZ-VD-3	White/Black Stripes	261,3	73	108
	İMİ-ÇRZ-VD-16	White/Black Stripes	275,4	74	108
	PALANCI 1 (C)	White Stripes in Black	222,0	74	109
Average			283,0	71,2	106,4
Standard Deviation			53,2	1,4	2,0
Max			369,0	74	110
Min			171,5	69	104



Seed Color & Seed Yield

- The seed colors of the varieties included in the study varied as **White Stripes in Black**, **White** and **White/Black Stripes**, and the most of them **White Stripes in Black** color was observed.
- Highest seed yield obtained from **TG-400** hybrid, was followed by **22-ÇRZ-VD-116**, **22-ÇRZ-VD-318**, **22-ÇRZ-VD-101**, **AFFAN**, **22-ÇRZ-VD-213**, **G1**, **22-ÇRZ-VD-104** and **22-ÇRZ-VD-113** hybrids respectively. In the study, the lowest yields were obtained from **AHMETBEY (C)** and **DENIZLI BEYAZI (C)** control types (local varieties).



Flowering & Physiological Maturity Days

- Early harvest is an important and desirable character in sunflower (because the vegetation period of confectionery varieties is generally longer than that of oils), and
- the earliest variety was observed as **AHMETBEY** with 69 days according to the flowering period, and **TG-400** and other candidates according to physiological maturity.
- The later varieties are; according to flowering, **PALANCI** and **IMI-ÇRZ-V-16**, and according to physiological maturity, **22-ÇRZ-VD-112**, **22-ÇRZ-VD-113** and **22-ÇRZ-VD-318** were observed.

#	Name	Taste Assessment*	Oleic Acid (%)	Oil Content (%)	Seed Width (cm)	Seed Size (cm)	Seed Thickness (cm)	1000 Seed Weight (g)
1	22-ÇRZ-VD-113	T:4 M:3 İ:2	64,52	29,79	0,8	2,0	0,4	161,5
2	22-ÇRZ-VD-116	T:4 M:4 İ:4	64,28	27,88	0,9	2,2	0,4	226,0
3	22-ÇRZ-VD-213	T:3 M:2 İ:2	55,61	31,75	0,6	2,0	0,4	161,7
4	22-ÇRZ-GB-30	G:4 T:4	61,72	31,36	0,9	2,3	0,4	223,7
5	22-ÇRZ-GB-19	G:4 T:4 M:5	62,01	30,15	0,8	2,2	0,4	205,5
6	22-ÇRZ-GB-24	G:5 T:5	60,34	26,77	0,7	2,2	0,4	194,3
7	22-ÇRZ-VD-318	T:4 G:3	62,89	28,62	0,9	2,3	0,5	214,2
8	22-ÇRZ-VD-103	T:5 G:4 M:5	63,23	29,93	0,8	2,0	0,4	192,8
9	22-ÇRZ-VD-101	T:4 G:4	60,37	26,82	0,8	2,1	0,4	185,2
10	22-ÇRZ-VD-110	T:3	64,30	26,20	0,9	2,4	0,5	193,3
11	22-ÇRZ-VD-112	T:3	61,32	33,99	0,7	2,1	0,3	161,5
12	22-ÇRZ-VD-104	T:2	60,41	22,82	0,8	1,9	0,3	151,5
13	22-ÇRZ-VD-105	T:4 G:5	63,83	29,30	0,9	2,1	0,4	207,3
14	22-ÇRZ-VD-111	T:4 G:4	54,83	34,54	0,6	2,0	0,3	155,7
15	22-ÇRZ-VD-109	T:5	63,29	29,94	0,9	2,2	0,3	203,7
16	STRİPi	T:4 D:4	66,97	32,59	0,7	2,0	0,3	138,7
17	DENİZLİ BEYAZI(C)	T:4 D:4	60,14	31,57	0,7	1,6	0,3	140,5
18	AHMETBEY (C)	T:4 D:4	74,39	27,56	0,9	2,1	0,4	172,3
19	İMİ-ÇRZ-VD-6	T:4,5 D:4,5	62,71	34,79	0,8	1,9	0,4	142,2
20	G1	T:5 D:4	64,16	30,25	0,9	2,0	0,4	153,2
21	TG400 (C)	T:5 D:5 M:5	63,39	30,94	0,8	2,1	0,3	151,2
22	AFFAN	T:4 D:4	62,51	29,40	0,9	2,1	0,4	155,2
23	İMİ-ÇRZ-VD-3	T:4,5 D:5	64,59	34,22	0,8	2,0	0,4	143,5
24	İMİ-ÇRZ-VD-16	T:4,5 D:4,5	65,55	30,90	0,9	1,8	0,4	170,0
25	PALANCI 1 (C)	T:3 D:3	64,74	35,59	0,7	1,8	0,4	134,7
Average			62,9	30,3	0,8	2,1	0,4	173,6
Standard Deviation			3,7	3,0	0,1	0,2	0,0	28,5
Max			74,4	35,6	0,9	2,4	0,5	226,0
Min			54,8	22,8	0,6	1,6	0,3	134,7

Taste Assessment & Oleic Acid (%)

- Taste evaluation in unroasted seeds of the varieties included in the experiment; It was based on the grades given by participants on seeds (**5: Most delicious 1: Worst**) out of 5.
- In this context, the **TG 400** variety received the highest grade and the **IMI-ÇRZ-VD-3, IMI-ÇRZ-VD-16, İMİ-ÇRZ-VD-6, 22-ÇRZ-GB-19, 22-ÇRZ-GB-24, 22-ÇRZ-VD-103** and **22-ÇRZ-VD-105** were among the varieties that received high marks.
- **High oleic acid** in sunflower a desired and preferred traits in terms of preventing the oil from burning during frying-roasting, extending its shelf life and increasing its flavor.
- The oleic acid contents measured first with the Spinlock 200 SLK NMR together with the oil content directly with the shell.
- The **oleic acid** of the varieties changed **54.8% and 74.4%**.
- The highest oleic acid ratio was measured in **AHMETBEY** and the lowest rate was measured in **22-ÇRZ-VD-111**.

Oil Content

- The high oil content of confectionery sunflower is an undesirable feature, and in general, an oil content above 30% is not preferred both in terms of cholesterol and diet, as it increases the bitterness by taking moisture in a short time.
- The oil content of the varieties was around 30% on average and results between **22.8-35,6 %**.
- While the highest oil content was measured in the **PALANCI 1**,
- The lowest oil content was measured in the **22-ÇRZ-VD-104** line, and as a matter of fact, this variety was observed as a variety with the lowest taste score.

Seed Width-Length-Thickness & 1000 Seed Weight

- Seed size, as seed width (cm), seed length (cm) and seed thickness (cm) characters, is the most important feature desired in confectionery sunflower.
- Consumers generally prefer longer seeds.
- The **seed widths** ranged between **0.6 cm and 1 cm**.
- **Seed length** values ranged between **1.6 and 2.5 cm**.
- **Seed thickness** values ranged from **0.27 cm to 0.50 cm**.
- **1000 seed weight** esp in Turkey, confectionery sunflower products are exchanged after harvest with sieves of certain sizes, and it is one of the most important criteria that determine the quality and price for the buyer and seller.
- Normally, seeds of **150 g and above are of an acceptable** value in the market, and varieties weighing 200 g and above can be considered as large and most preferred varieties.
- In the study, the **TSW of the varieties** were **between 130.0 g and 248.5 g**, and the **22-ÇRZ-VD-116** line had the highest thousand seed weight.

Name	% Humidity	% Protein	Water Activity	pH (Raw)	pH (Roasted)	Peroxide # (meq O2/kg)
22-ÇRZ-VD-113	3.15 ± 0.03	25,48	0.465 ± 0.005	7,00 ± 0,05	6,17 ± 0,06	14.75± 1,05
22-ÇRZ-VD-116	3.20 ± 0.05	25,11	0.447 ± 0.009	6,77 ± 0,06	5,96 ± 0,04	57.5± 3,11
22-ÇRZ-VD-213	3.30 ± 0.05	18,42	0.421 ± 0.007	6,78 ± 0,08	5,85 ± 0,04	21.5± 0,95
22-ÇRZ-GB-30	2.98 ± 0.04	20,72	0.424 ± 0.003	6,63 ± 0,04	5,42 ± 0,04	62.5± 1,21
22-ÇRZ-GB-19	2.91 ± 0.03	24,10	0.459 ± 0.006	6,81 ± 0,11	5,77 ± 0,06	16.5± 3,15
22-ÇRZ-GB-24	2.81 ± 0.05	27,14	0.47 ± 0.004	6,83 ± 0,05	5,72 ± 0,03	83.5± 2,28
22-ÇRZ-VD-318	3.02 ± 0.05	22,68	0.448 ± 0.009	6,68 ± 0,06	5,56 ± 0,05	4.5± 0,32
22-ÇRZ-VD-103	2.68 ± 0.04	20,74	0.462 ± 0.008	6,64 ± 0,04	5,64 ± 0,04	12.5± 0,85
22-ÇRZ-VD-101	3.06 ± 0.06	23,78	0.447 ± 0.009	6,72 ± 0,05	5,32 ± 0,02	16.5± 0,59
22-ÇRZ-VD-110	2.69 ± 0.04	21,05	0.443 ± 0.005	6,79 ± 0,04	5,82 ± 0,04	19.5± 1,33
22-ÇRZ-VD-112	2.41 ± 0.01	23,23	0.454 ± 0.008	6,84 ± 0,04	5,49 ± 0,05	13.5± 0,24
22-ÇRZ-VD-104	3.13 ± 0.03	26,89	0.443 ± 0.007	6,41 ± 0,02	5,60 ± 0,04	9.5± 0,34
22-ÇRZ-VD-105	2.47 ± 0.05	23,71	0.445 ± 0.008	6,95 ± 0,02	5,60 ± 0,03	7.5± 2,42
22-ÇRZ-VD-111	3,00 ± 0.11	21,82	0.447 ± 0.005	6,68 ± 0,06	5,38 ± 0,04	32.5± 1,21
22-ÇRZ-VD-109	2.62 ± 0.03	24,41	0.45 ± 0.003	6,59 ± 0,05	6,01 ± 0,13	27.5± 1,65
STRİPİ	3.09 ± 0.13	22,12	0.453 ± 0.002	6,90 ± 0,04	5,85 ± 0,06	26.5± 0,58
DENİZLİ BEYAZI(C)	2.63 ± 0.09	17,87	0.442 ± 0.008	6,80 ± 0,03	5,67 ± 0,02	124.5± 3,25
AHMETBEY (C)	2.92 ± 0.09	30,05	0.45 ± 0.004	6,92 ± 0,06	5,86 ± 0,05	83.5± 0,95
İMİ-ÇRZ-VD-6	2.92 ± 0.06	20,50	0.446 ± 0.006	6,94 ± 0,07	5,87 ± 0,02	7.5± 0,25
G1	2.43 ± 0.09	19,67	0.454 ± 0.008	6,99 ± 0,07	6,14 ± 0,06	7.5± 0,16
TG400 (C)	2.27 ± 0.12	24,82	0.465 ± 0.002	6,77 ± 0,03	6,04 ± 0,01	8.5± 0,44
AFFAN	2.82 ± 0.11	21,15	0.454 ± 0.009	7,01 ± 0,01	5,94 ± 0,12	3.5± 0,21
İMİ-ÇRZ-VD-3	2.67 ± 0.04	21,63	0.455 ± 0.005	7,04 ± 0,06	6,04 ± 0,04	9.5± 0,81
İMİ-ÇRZ-VD-16	2.80 ± 0.08	22,84	0.454 ± 0.005	6,97 ± 0,08	5,8 ± 0,03	7.5± 0,22
PALANCI 1 (C)	2.58 ± 0.05	19,63	0.452 ± 0.006	7,01 ± 0,11	5,75 ± 0,06	8.5
Average	2,82	22,78	0,45	6,82	5,77	27,47
Standard Deviation	0,27	2,86	0,01	0,16	0,23	30,84
Max	3,30	30,05	0,47	7,04	6,17	124,5
Min	2,27	17,87	0,42	6,41	5,32	4,5

% Humidity, % Protein & Water Activity

- **The % moisture content** of the samples was found to be between **3.3% and 2.41%**.
- Soleimanieh et al. (2015) found that the moisture content of sunflower seeds decreased from about 4.5% to 1% depending on the roasting conditions.
- The high **protein value** of confectionery sunflower is a preferred feature in terms of nutrition, and it is desired that the seeds have a high protein value. **The protein** values of the varieties varied between **17.87 and 30.05%**, and the **highest protein value** was observed in the **AHMETBEY** control variety and **the lowest protein** ratio was measured in the **DENIZLI BEYAZI**.
- **The water activity** values of the unshelled sunflower samples were found to be below 0.6 water activity in all samples. Water activity values were determined between **0.470 and 0.442** in the samples. From this point of view, samples can be considered microbiologically safe to deteriorate.

pH and Peroxide Value

- The **pH values** of unroasted sunflower seed samples ranged from **7.04 to 6.59**.
- In roasted samples, this range varied between **6.17 and 5.32**.
- The pH value of sunflower seeds varies depending on the roasting temperature and duration.
- Peroxide number shows the degree of oxidation of oil-containing products with the number of peroxides.
- In general, the peroxide value increases with the application of heat treatment (Juhami et al., 2018).
- The peroxide values of the samples ranged from **4.5 to 124.5**, and the high peroxide value indicates that some samples were exposed to a high amount of oxidation.

#	Name	Total Amount of Phenolic Substances (mg GAE/100 g KM)
1	22-ÇRZ-VD-113	2262 ± 60 j*
2	22-ÇRZ-VD-116	1403 ± 93 cd
3	22-ÇRZ-VD-213	2207 ± 63 ij
4	22-ÇRZ-GB-30	1782 ± 67 fg
5	22-ÇRZ-GB-19	1536 ± 73 de
6	22-ÇRZ-GB-24	1855 ± 47 gh
7	22-ÇRZ-VD-318	1701 ± 51 f
8	22-ÇRZ-VD-103	2505 ± 47 k
9	22-ÇRZ-VD-101	1230 ± 90 b
10	22-ÇRZ-VD-110	1352 ± 57 c
11	22-ÇRZ-VD-112	1768± 51 fg
12	22-ÇRZ-VD-104	1570 ± 61 e
13	22-ÇRZ-VD-105	2212 ± 94 ij
14	22-ÇRZ-VD-111	2215 ± 43 l
15	22-ÇRZ-VD-109	2112 ± 70 l
16	STRİPİ	1543 ± 60 e
17	DENİZLİ BEYAZI(C)	1386 ± 72 cd
18	AHMETBEY (C)	1394 ± 55 cd
19	İMİ-ÇRZ-VD-6	1317 ± 50 bc
20	G1	1731 ± 60 f
21	TG400 (C)	1505 ± 55 e
22	AFFAN	2143 ± 61 ij
23	İMİ-ÇRZ-VD-3	1219 ± 47 b
24	İMİ-ÇRZ-VD-16	943 ± 68 a
25	PALANCI 1 (C)	1396 ± 64 h
Average		1707,9
Standard Deviation		398,0
Max		2505,0
Min		943,0

Total Amount of Phenolic Substances

- It is desirable that phenolic substances in confectionery sunflower is higher containing antioxidant substances and some beneficial compounds in terms of nutrition.
- However, some phenolic compounds can cause bitter or undesirable taste, sensory sensations to consumers
- However, phenolic compound analyses were not carried out fully in the project, just checked the total amount.
- The total phenolic substance content of unshelled sunflower seed samples ranged from **943 to 2505**.
- Among the varieties, the **22-ÇRZ-VD-103** candidate line had the **highest phenolic substance** content, and the **lowest value** was observed in the **IM-ÇRZ-VD-16** candidate line.

Total Amount of Phenolic Substances

- Nadeem et al. (2011) found that the total amount of phenolic substances in the samples ranged between 2185 – 2965 mg/100g in shelled samples and 3162 – 3614 mg GAE/100g in unshelled seed samples.
- Fiska et al. (2006) determined the total phenolic substance content of unshelled sunflower samples as 2700 mg GAE / 100 g dry matter.
- Ali et al. (2023) found the total phenolic substance content of unshelled sunflower seed samples to be between 1930 – 2310 mg GAE/100g.
- Within the scope of the project, the total phenolic substance content was generally found to be compatible with the literature.

#	Na	Mg	Al	K	Ca
1	9.56±0.28	1515.35±29.19	5.84±0.61	3755.46±75.57	611.21±10.64
2	8.49±0.24	1297.36±4.67	0.59±0.1	4396.58±46.71	444.35±18.87
3	9.43±0.33	1181.63±27.46	0.44±0.08	3118.58±76.21	453.57±10.38
4	9.09±0.40	1449.1±40.89	0.49±0.09	4691.64±113.12	444.51±18.26
5	9.29±0.20	1373.56±9.59	0.66±0.17	4579.55±30.65	451.1±26.05
6	9.46±0.18	1632.99±24.26	0.95±0.05	4150.46±67.71	508.25±41.28
7	9.01±0.05	1647.87±14.89	1.39±0.1	5685.11±73.59	389.66±28.31
8	3.16±0.23	1427.55±46.67	0.53±0.09	4214.61±75.96	420.96±12.23
9	3.02±0.34	1740.56±36.85	0.61±0.1	4824.02±142.95	803.65±26.95
10	2.65±0.13	1288.44±19.88	0.36±0.07	3909.63±84.54	315.05±13.84
11	3.57±0.08	1418.32±26.8	0.49±0.04	3576.58±21.95	477.62±18.24
12	1.70±0.09	1600±6.49	0.35±0.13	6855.34±127.67	664.59±26.54
13	2.04±0.25	1489.42±29.3	0.44±0.08	4915.62±42.82	497.71±11.16
14	3.52±0.08	1279.59±7.21	0.42±0.13	3710.74±33.24	480.09±11.02
15	2.62±0.21	1381.21±22.36	2.36±0.22	4421.66±89.9	468.39±27.69
16	3.16±0.23	2694.15±61.05	0.37±0.02	6176.06±201.07	465.59±14.33
17	2.4±0.20	2569.15±50.54	0.36±0.08	5827.75±140.78	612.7±20.99
18	2.24±0.07	2395.98±49.21	0.28±0.05	5604.06±115.64	401.52±23.70
19	3.10±0.09	2382.11±24.35	0.25±0.09	5493.39±67.93	532.8±22.43
20	1.38±0.04	2666.91±54.96	0.14±0.03	7252.17±134.34	629.99±45.03
21	1.39±0.21	2712.82±72.85	1.80±0.05	6524.8±219.87	606.27±15.91
22	2.15±0.21	2680.07±10.26	0.39±0.04	6750.76±19.68	561.63±11.87
23	3.91±0.24	2637.62±27.78	0.48±0.03	5908.92±70.07	621.42±29.16
24	3.09±0.07	2304.13±10.56	0.25±0.08	5928.71±15.44	724.56±15.16
25	2.31±0.08	2750.42±19.70	2.58±0.10	6661.9±114.85	664.76±26.25
Average	4,48	1899,06	0,91	5138,35	530,25
Standard Deviation	3,06	584,10	1,21	1139,85	113,74
Max	9,56	2750,42	5,84	6855,34	818,07
Min	1,39	1181,63	0,20	3118,58	315,05

Elemental Content Analysis

- The amount of magnesium in the samples ranged from **2694 to 1181 mg/kg**, potassium from **6855 to 3576 mg/kg**, and calcium from **803 to 315 mg/kg**.
- In a study conducted in Argentina, it was determined that the amounts of magnesium, potassium and calcium in sunflower seeds were approximately between 5000 - 6000, 1300 -1000 and 1200-1600 mg/kg, respectively (Tesan et al, 2022).
- In terms of nutrition, it is desirable to have high amounts of some macro elements such as Mg, K, Ca in confectionery sunflower.
- However, it is very difficult to comment which of these is effective and plays a decisive role in the taste and consumption preferences of consumers.

#	Mo	Ag	Cd	Sn	Ba	N i	Cu	Zn
1	8,48±0,45	1,41±0,04	1,27±0,05	2,18±0,2	1,11±0,04	7,11±0,15	64,75±0,63	269,76±1,93
2	5,21±0,06	0,83±0,02	0,9±0,01	1,74±0,03	0,54±0,02	6,8±0,18	78,22±2,87	218,64±2,31
3	3,44±0,07	0,59±0,01	0,62±0,02	1,32±0,02	0,72±0,04	6,04±0,12	60,3±0,72	208,27±0,58
4	3,16±0,09	0,35±0,02	1,03±0,02	1,1±0,06	0,7±0,04	6,09±0,07	81,23±0,98	237,07±2,49
5	2,78±0,04	0,25±0,02	1,11±0,03	1,04±0,01	0,75±0,07	8,29±0,04	78,87±0,52	211,13±1,61
6	2,93±0,04	0,19±0,01	0,79±0,03	0,85±0,05	0,78±0,02	7,83±0,05	84,13±0,25	243,36±3,05
7	2,96±0,05	0,16±0,01	1,16±0,03	0,81±0,01	0,57±0,03	8,17±0,12	93,58±1,12	235,42±1,19
8	2,11±0,07	0,16±0,01	0,99±0,01	0,58±0,03	0,44±0,03	7,89±0,21	75,18±1,74	226,69±1,39
9	2,34±0,03	0,1±0,01	0,98±0,06	0,55±0,01	0,6±0,03	6,55±0,1	88,36±1,34	260,72±2,03
10	2,07±0,01	0,07±0	0,97±0,03	0,55±0,02	0,31±0,01	6,51±0,2	81,63±1,33	210,47±1,79
11	2,05±0,03	0,07±0,01	0,99±0,02	0,52±0,06	0,93±0,03	5,73±0,1	91,65±0,91	265,59±3,52
12	2,64±0,06	0,05±0	0,87±0,04	0,39±0,01	0,5±0,02	9,16±0,1	74,69±1,59	251,78±3,17
13	2,49±0,04	0,04±0,01	1,63±0,1	0,37±0,01	0,57±0,05	6,71±0,17	95,88±1,5	255,15±3,44
14	1,73±0,05	0,04±0	0,85±0,07	0,43±0,07	0,65±0,02	9,89±0,11	71,06±0,03	219,3±2,53
15	2,31±0,01	0,03±0	1,3±0,08	0,34±0,01	0,77±0,03	5,9±0,02	94,72±0,98	268,03±1,5
16	1,34±0	0,02±0	0,92±0,04	0,28±0,02	0,61±0,02	15,21±0,2	67,06±0,6	210,82±1,75
17	0,9±0,02	0,03±0	0,69±0,03	0,26±0,02	0,74±0,03	22,13±0,1	84,68±1,26	210,89±2,74
18	0,99±0,02	0,02±0	0,57±0,01	0,25±0,02	0,61±0,02	21,59±0,24	81,25±1,49	201,28±2,22
19	0,93±0,02	0,01±0,01	0,7±0,03	0,22±0,01	1,5±0,04	12,66±0,06	70,72±1,26	225,91±3,97
20	1,24±0,03	0,01±0,01	0,78±0,1	0,18±0,01	1,18±0,01	14,29±0,07	72,15±1,16	231,76±3,46
21	1,43±0,02	0,01±0	0,78±0,01	0,19±0,03	1,23±0,03	13,27±0,27	86,85±1,82	247,76±2,62
22	1,33±0,03	0,02±0	0,72±0,01	0,15±0,02	1,23±0,04	12,84±0,18	72,16±1,03	218,5±2,03
23	0,89±0,02	0,01±0	0,75±0,03	0,15±0,02	1,41±0,04	14,73±0,19	76,07±0,56	241,89±1,86
24	0,91±0,04	0,01±0	0,61±0,05	0,15±0,03	2,12±0,01	14,7±0,06	72,01±1,26	215,14±2,8
25	1,11±0,02	0±0	0,85±0,01	0,15±0	1,4±0,06	13,3±0,03	80,98±1,47	271±2,84
Average	2,30	0,18	0,91	0,59	0,87	0,11	10,64	79,28
Std Dev	1,65	0,32	0,24	0,53	0,41	0,03	4,83	9,35
Max	8,48	1,41	1,63	2,18	2,12	0,18	22,13	95,88
Min	0,89	0,00	0,61	0,15	0,31	0,07	5,73	60,30

#	As	Se	Li	Cr	Mn	Fe	Co	Pb
1	0,6±0,11	0,15±0,31	NA	0,17±0	0,18±0,22	2,93±0,14	0,04±0	0,16±0,04
2	0,49±0,05	0,27±0,18	0,69±0,94	0,32±0,03	62,26±0,44	179,57±1,83	0,31±0,02	0,08±0,01
3	0,4±0,04	0,23±0,06	NA	0,62±0,03	66,73±0,67	165,93±3,05	0,09±0	0,06±0,01
4	0,26±0,05	0,29±0,11	NA	0,18±0	57,46±0,3	158,13±1,1	0,07±0,01	0,09±0,02
5	0,28±0,04	0,33±0,32	0,82±1,54	0,26±0,01	64,05±0,33	166,79±1,89	0,14±0,01	0,07±0,02
6	0,23±0,02	0,17±0,11	NA	0,47±0,02	66,09±0,21	177,72±0,66	0,35±0	0,09±0,01
7	0,23±0,06	0,23±0,19	NA	0,17±0,01	79,06±0,89	223,55±2,01	0,09±0,01	0,07±0,01
8	0,19±0,03	0,27±0,04	0,09±0,27	0,2±0	73,74±1,11	255,22±2,7	0,09±0	0,12±0,01
9	0,2±0,08	0,29±0,09	0,32±0,4	0,05±0	65,54±0,68	173,35±1,02	0,13±0,01	0,11±0,01
10	0,19±0,03	0,21±0,16	0,09±0,33	0,04±0	88,29±0,42	199,76±2,06	0,09±0,02	0,11±0,01
11	0,16±0,01	0,27±0,1	0,85±0,24	0,08±0,01	74,27±0,55	181,15±2,12	0,08±0	0,15±0,03
12	0,14±0,01	0,15±0,27	0,63±0,27	0,15±0,01	62,68±0,95	185,2±3,39	0,14±0	0,11±0,02
13	0,12±0,02	0,08±0,13	NA	0,04±0	80,9±0,69	173,81±0,77	0,12±0,01	0,15±0,02
14	0,14±0,02	NA	NA	0,04±0,01	79,52±1,18	172,46±2,13	0,11±0,01	0,13±0,03
15	0,2±0,06	NA	NA	0,11±0	51,48±0,54	153,71±1,43	0,11±0	0,13±0,01
16	0,16±0,04	1,09±0,45	NA	0,05±0,01	76,28±0,57	192,65±1,27	0,11±0,01	0,11±0,02
17	0,13±0,02	1,13±0,38	NA	0,12±0,01	95,87±0,7	146,39±1,23	0,2±0,02	0,12±0,02
18	0,13±0,05	1,32±0,2	0,09±0,27	0,03±0,01	117,9±1,61	180,93±1,43	0,82±0,01	0,11±0,01
19	0,12±0,04	1,46±0,25	0,69±0,68	0,12±0	127,89±0,15	181,8±1,93	0,32±0,01	0,12±0,01
20	0,12±0,01	1,38±0,14	NA	0,03±0	79,91±1,26	180,6±2,31	0,33±0,01	0,13±0,01
21	0,14±0,04	1,09±0,13	NA	0,03±0,01	75,12±0,96	172,62±0,95	0,26±0	0,12±0,01
22	0,11±0,01	1,15±0,18	0,38±0,2	0,06±0	97,21±0,77	190,9±1,3	0,2±0,01	0,11±0,01
23	0,11±0,02	1,32±0,72	NA	0,05±0,02	69,98±1,23	157,46±1,33	0,27±0	0,12±0,02
24	0,08±0,02	0,81±0,35	0,57±0,49	0,04±0	96,06±0,54	178,08±1,97	0,29±0	0,11±0,01
25	0,16±0,04	1,11±0,6	NA	0,05±0,01	95,19±1,45	175,68±1,8	0,19±0	0,17±0,02
Average	234,1	0,20	0,60	0,33	0,13	79,44	180,5	0,22
Standard Dev	22,1	0,12	0,50	0,26	0,15	18,09	22,1	0,17
Max	271,0	0,60	1,50	0,85	0,62	124,20	255,2	0,82
Min	204,8	0,09	0,06	0,00	0,03	51,48	146,4	0,07

Elemental Content Analysis

- Heavy metal contents such as arsenic, lead and cadmium were found to be below 2 ppb in the samples.
- In a study conducted in Iran, it was reported that the lead and cadmium contents in sunflower seed samples ranged between 10-381 and 73-731 ppb, respectively (Torki et al., 2018).
- In all of the samples examined within the scope of the study, a much lower amount of cadmium and lead was detected.
- However, in the microelement analysis of the varieties included in the project, a high value in terms of heavy metals was not determined.

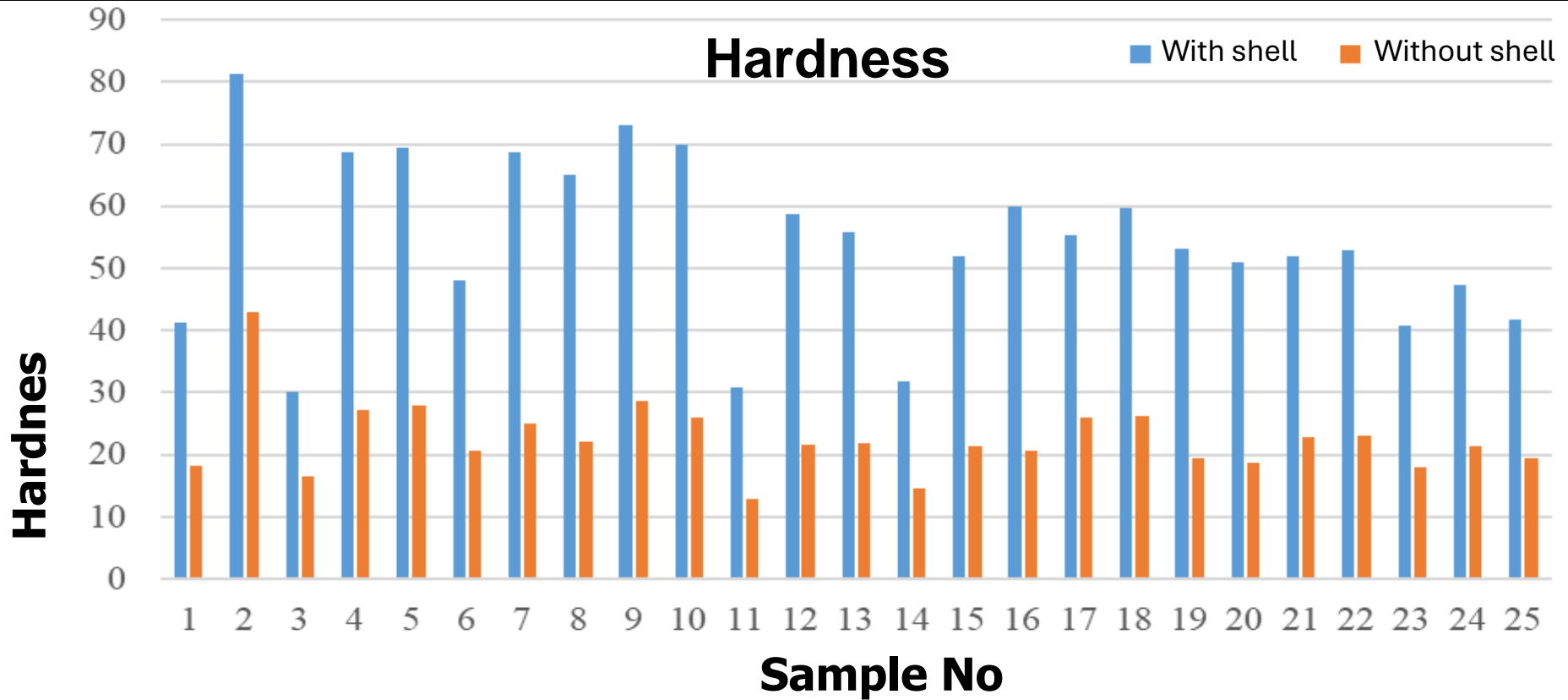
#	Palmitic acid	Stearic acid	Oleic acid	Linoleic acid	Linolenic acid	Arachidic acid	Eicosenoic acid	Behenic acid
1	4.99	3.33	38.79	47.99	1.27	0.62	0.27	1.41
2	6.27	2.66	43.24	46.42	0.27	0.08	0.19	0.63
3	6.02	3.38	36.60	52.76	0.22	0.04	0.10	0.70
4	6.61	2.62	39.92	49.39	0.20	0.05	0.13	0.70
5	5.94	2.13	42.22	48.47	0.14	0.11	0.14	0.58
6	5.98	3.8	38.43	50.26	0.25	0.12	0.12	0.81
7	6.23	2.32	38.87	51.38	0.15	0.05	0.14	0.54
8	5.98	2.36	43.58	44.76	0.13	0.78	0.13	0.53
9	6.23	3.01	37.51	51.82	0.22	0.06	0.13	0.56
10	6.21	3.21	42.77	46.36	0.22	0.11	0.14	0.58
11	5.60	3.80	45.73	43.27	0.23	0.06	0.11	0.91
12	7.19	2.45	31.25	57.59	0.15	0.08	0.13	0.35
13	6.21	2.72	41.68	46.86	0.18	0.04	0.12	0.58
14	5.47	2.93	40.09	50.18	0.17	ND	0.15	0.77
15	6,00	2.73	45.38	44.58	0.20	ND	0.12	0.63
16	5.62	2.89	46.34	43.49	0.19	0.06	0.18	0.65
17	6.17	2.73	36.36	53.25	0.19	0.09	0.16	0.64
18	5.42	4.12	47.60	40.99	0.28	0.05	0.14	0.78
19	6.01	2.60	41.25	48.25	0.21	0.06	0.16	0.89
20	6.17	2.91	40.06	49.30	0.23	0.06	0.14	0.67
21	6.06	2.89	43.24	46.25	0.21	ND	0.13	0.69
22	6.23	2.92	39.68	49.64	0.21	0.06	0.13	0.73
23	4.96	3.1	48.25	42,00	0.22	0.04	0.15	0.86
24	5.54	2.98	40.98	48.91	0.20	0.06	0.13	0.75
25	5.48	3.12	41.47	48.57	0.21	0.05	0.14	0.61
Average	5,94	2,95	41,25	48,11	0,25	0,12	0,14	0,70
Standard Dev	0,48	0,47	3,85	3,79	0,22	0,19	0,03	0,19
Max	7,19	4,12	48,25	57,59	1,27	0,78	0,27	1,41
Min	4,96	2,13	31,25	40,99	0,13	0,04	0,10	0,35

Determination of Oil Content & Fatty Acids Composition

- According to the Turkish food codex, the amount of **oleic acid in sunflower oil should be between 17 -71.8 %** and the amount of **linoleic acid should be between 18.7 – 74 %**.
- When all the samples were examined, it was determined that the samples showed a fatty acid composition that complied with the criteria in the codex.
- The crude oils of the varieties included in the study were extracted by a conventional crushed crude oil extraction machine.
- Fatty acid analyzes were performed in the Gas Chromatography device using crude oils obtained from the varieties.

Determination of Oil Content & Fatty Acids Composition

- Linolenic (Omega 3) fatty acid found in vegetable oils is a feature that is especially preferred in nutrition and is desired to be high in terms of nutrition in confectionery sunflower.
- In this context, the linolenic acid percentages of the varieties ranged between **0.13-1.27%** and the highest rate was the **22-ÇRZ-VD-113**.
- The oleic acid ratios, which significantly affect the quality of the varieties and increase the shelf life, varied between **31.25 and 48.25%**.
- The highest oleic acid ratio was measured in **IMI-ÇRZ-VD-3** and the lowest rate was measured in line **22-ÇRZ-VD-104**.
- Differences were found between the oleic acid ratios measured with shell and the ratios measured in GC. Significant cross-line changes were observed among other fatty acid ratios.
- In particular, oleic, linoelic and linolenic fatty acids are involved in the formation of aldehydes such as hexanal as a result of oxidation, so the amount of these fatty acids affects the sensory properties of the final product (Guo et al., 2019).



- Seed hardness is an undesirable feature in confectionery sunflower, and when the seed is very hard, it is not preferred in terms of both excessive energy consumption during roasting and reducing easy breakage during consumption.
- In this context, the seed hardness values of the lines varied between **30.17-81.26 kg** with shell and **12.86-43.07** without shell.
- The hardest seeds were found in the **22-ÇRZ-VD-116** line with and without shells, while the softest grains were observed in the **22-ÇRZ-VD-112** line.
- In terms of seed hardness, there is generally a parallelism between shelled and unshelled values, and control varieties generally exhibited values close to the mean in both measurements.

#	Name	Colour	Aroma	Taste	Crumbled	General
1	22-ÇRZ-VD-113	3,0± 0	3,9± 0,3	4,0± 0	3,0± 0	3,3± 0,5
2	22-ÇRZ-VD-116	1,8± 0,4	3,0± 0	4,2± 0,4	3,7± 0,5	3,2± 0,6
3	22-ÇRZ-VD-213	1,3± 0,9	4,1± 0,3	4,0± 0,0	3,0± 0	3,2± 0,4
4	22-ÇRZ-GB-30	2,8± 0,4	2,2± 0,6	4,0± 0,0	4,0± 0,0	2,0± 0
5	22-ÇRZ-GB-19	3,0± 0	4,4± 1,1	4,2± 0,8	4,0± 0,0	4,3± 0,6
6	22-ÇRZ-GB-24	3,0± 0	1,0± 0	1,4± 1,1	3,1± 0,3	2,9± 0,3
7	22-ÇRZ-VD-318	1,2± 0,6	2,3± 0,8	1,2± 0,4	3,2± 0,4	1,2± 0,4
8	22-ÇRZ-VD-103	1,0± 0	3,9± 0,3	3,8± 0,8	4,2± 0,9	3,0± 0,8
9	22-ÇRZ-VD-101	1,3± 0,8	3,3± 0,6	4,1± 0,3	3,1± 0,3	2,9± 0,3
10	22-ÇRZ-VD-110	2,5± 0,9	3,4± 1,1	3,8± 0,8	3,9± 0,3	2,8± 0,8
11	22-ÇRZ-VD-112	3,0± 0	3,4± 0,8	3,1± 1,4	3,6± 0,5	2,3± 0,8
12	22-ÇRZ-VD-104	3,0± 0	3,8± 0,4	1,7± 1,3	3,9± 0,3	3,5± 0,5
13	22-ÇRZ-VD-105	3,0± 0	4,1± 0,3	4,2± 0,4	3,9± 0,3	4,2± 0,9
14	22-ÇRZ-VD-111	2,9± 0,3	4,0± 0	4,0± 0,0	3,9± 0,3	3,7± 0,5
15	22-ÇRZ-VD-109	3,0± 0	3,2± 0,4	4,0± 0,0	3,2± 0,4	2,5± 0,8
16	STRİPİ	2,8± 0,4	4,6± 0,8	4,2± 0,4	1,0± 0	3,2± 0,4
17	DENİZLİ BEYAZI (C)	2,0± 0,6	1,8± 1,5	1,8± 1,5	4,0± 0	2,6± 0,9
18	AHMETBEY (C)	2,6± 0,7	3,7± 0,8	3,8± 0,9	3,8± 0,4	2,7± 1,4
19	İMİ-ÇRZ-VD-6	2,5± 0,9	1,5± 1,1	1,8± 1,3	3,0± 0	2,2± 1,1
20	G1	2,3± 1,1	2,7± 0,8	3,3± 1,3	3,2± 0,4	2,1± 1
21	TG400 (C)	2,9± 0,3	4,3± 0,8	3,8± 1,5	3,8± 0,4	3,9± 1
22	AFFAN	2,8± 0,4	4,3± 0,5	4,2± 0,4	3,1± 0,3	2,9± 0,6
23	İMİ-ÇRZ-VD-3	2,9± 0,3	2,5± 1,1	3,8± 1,1	3,2± 0,4	3,8± 0,4
24	İMİ-ÇRZ-VD-16	3,0± 0	3,7± 0,8	2,8± 1,5	3,8± 0,4	2,7± 0,5
25	PALANCI 1 (C)	3± 0	4± 0	4± 0	3,9± 0,3	3,1± 0,3
Average		2,50	3,32	3,41	3,45	2,97
Standard Deviation		0,66	0,97	1,00	0,64	0,72
Max		3,00	4,60	4,20	4,20	4,30
Min		1,00	1,00	1,20	1,00	1,20

Sensory Analysis

- When the general liking scores of the samples were examined; Samples 22-ÇRZ-GB-19, 22-ÇRZ-VD-105, 22-ÇRZ-VD-111 and TG400 received the most points by the panelists.
- The sample that received the lowest score in terms of general appreciation was example 22-ÇRZ-GB-30.
- 22-ÇRZ-GB-19 scored the highest in all sensory analysis parameters.
- Between control and foreign candidate varieties; TG 400 variety received the highest score, and Palancı and Ahmetbey control varieties had high values except for the general appearance.
- Among the candidate varieties, 22-ÇRZ-VD-105 and 22-ÇRZ-VD-111 lines again attracted attention with their high values, while the STRIPI variety was among the varieties that came to the fore with its high aroma and taste, AFFAN with its taste, and DENIZLI BEYAZI with its crispness.

<u>COMPOUND</u>	<u>AROMA</u>
2-Methylbutanal	Cakao, Almond
Hexanal	Grass, Oily
Heptanal	Oily, Woody
Nonanal	Citrus-like, Oily
2-Pentylfuran	Fruity
α-Pinene	Pine, Turpentine
β-Pinene	Balzamic
Camphene	Woody
2 pentyl furan	Butter, Green beans
2 pentene	Fruity, Bitter Almonds
2-butyl furan	Spicy-like
2-methyl-1-butanol	Malty
2-octenal	Fruity, Soap, Oily
2-butenal	-
2 hexanol	Fruity, Aromatic, Soft, Grass

Aroma Analysis

- In the aroma analysis carried out within the scope of the project, 2-Methylbutanal, Hexanal, Heptanal, Nonanal, 2-Pentylfuran, α -Pinene, β -Pinene, Camphene, 2 pentyl furan, 2-pentene, 2-butyl furan, 2-methyl-1-butanol, 2-octenal, 2-butenal and 2-hexanol aroma compounds were detected in confectionery varieties
- After the quantitative values of the aroma components in the samples are determined by further studies, detailed analyzes will be made on how effective these compounds are on taste and sensory analysis.

CONCLUSIONS

- Seed yield values in the project varied between **128 - 401 kg/da** and **TG-400** hybrid ranked first is important for producers.
- Seed colors of the varieties varied as **white striped in black, white and White/black**.
- According to the taste evaluation of raw grains of the varieties included in the research;
- **TG 400 variety got the highest grade,**
- followed by İMİ-ÇRZ-VD-3, İMİ-ÇRZ-VD-16, İMİ-ÇRZ-VD-6, 22-ÇRZ-GB-19, 22-ÇRZ-GB-24, 22-ÇRZ-VD-103 and 22-ÇRZ-VD-105 lines.
- 22-ÇRZ-VD-116 and 22-ÇRZ-GB-30 in coarse-grained, which is the primary preference of consumers; TG400, 22-ÇRZ-VD-110, 22-ÇRZ-VD-318, 22-ÇRZ-GB-19 lines.

CONCLUSIONS

- For the consumers side;
- Protein values of the varieties varied between **17.87-30.05%** and the highest value was observed in **Ahmetbey** variety.
- In terms of fatty acids, linolenic (Omega 3) fatty acid varied between **0.13-1.27%**, **22-ÇRZ-VD-113** and oleic acid varied between **31.25-48.25%** and the highest value was measured in **IMI-ÇRZ-VD-3** line.
- According to the sensory analyzes of the varieties; **22-ÇRZ-GB-19** line, and among the control and foreign candidate varieties; **TG 400** variety got the highest score.

CONCLUSIONS

- As a result, when evaluated together as consumers, industrialists and producers; it is preferred that the newly developed varieties are high yielding and early, with high oleic and linolenic fatty acids and protein ratios but low browning index and hardness, such as the TG 400 hybrid.
- As a result, the TG 400 variety came to the forefront in terms of many values and can be used as a standard variety in the evaluation of taste and other yield elements to be made from now on.
- These data are preliminary data of the project. We didn't conduct regression and correlation analysis yet. We want to add more samples and data for better results.



THANK YOU

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