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THE CHANGE OF SOME PHYSICOCHEMICAL PROPERTIES DEPENDING ON THE SOWING TIMES IN LOCAL PEA GENOTYPES*

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Abstract

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Pea is grown in developed countries mostly, has the highest yield and use varieties among edible legumes. There is no pea variety developed from local materials in Turkey. In fact, Turkey also takes part within pea's origin centers. Because of that, new variety development studies matter from the point of our country. However, while developing the variety not only its agronomic properties and durability against stres conditions, but also its nutrition and processing qualities should be high. Quality factors are affected from both genetic and environmental conditions. This study was conducted to determine the quality properties of local pea genotypes described morphologically before, and their alterations depend on planting time. In this study, 48 genotypes were used in total as 44 local lines and 4 local variety. Genotypes were sowed in split plot experimental design under Samsun conditions in winter (on Nowember) and early spring (on February). After dry harvest, colour on pea seed, hard seed ratio, cooking time, dry matter loss in cooking, starch and amylose ratios in seed were observed. Twenty two of genotypes are light-coloured seed, others are dark-coloured. Because dark-coloured genotypes darken the cooking water and their hard seed ratio (24.84%) and starch ratio (33.39%) are high, it was determined that they can be utilized as feed. It was determined that dark-coloured genotypes can evaluated as fodder, because they darken their cooking water, their high number of seed that not absorb water (24.84) and their high starch ratio (33.39%). It was determined early spring planting was suitable for edible use having high seed quality. It was found the average fragmenttion degrees of genotypes that have light-coloured seed was 33.10%, their average cooking time was 46.25 min, the average of their hard seed ratios was 3.39%, their average loss of dry matter loss in cooking was 11.67%, their average starch ratios in ssed was 32.94% and their average amylose ratios in ssed was 23.94%. 2 lines, having light-coloured seed were selected as the variety candidate to develope for edible consumption, because they had the lowest cooking times, fragmenttion degrees and hard seed ratio.

Key words: pea, physicochemical properties, local gene sources

Introduction

Legumes form an important part of diet programs in developed countries because of their nutritional values (McPhee and Muehlbauer, 2002). Recent research shows that the antioxidants, flavonoids, plant estrogens, vitamins, minerals, protein and fiber in legumes can help preverent and may even contribute to, the reversal of many major chronic diseases (URL-1). Dry peas are among the most powerful of pulses (URL-2). In addition, pea has the highest use of varieties within the legumes (such as its fruit, its seed, pea flour, protein concentrates, pea fiber, functional food exracting its starch etc.). Flours obtained from pea seeds used for making a soup, in baby formula and different food as protein concentrator. Pea's fresh pod as vegetable, its fresh seeds for canning and as frozen food are used for food industry (Akçin, 1988).

Legumes are protein plants as well as carbohydrate-rich. The starch which is the predominant carbohydrate in our diets is used as the main carbon reserve in pea (Wang et al., 1998). In humans, starch is normally consumed as part of cooked or processed food. After this processes, a proprotion of the

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starch is recrystallized on cooling to become highly resistant to pancreatic amylose (retrograded) and cannot be digested so called "resistant starch". Resistant starch contributes to the total unavailable carbohydrates believed to be important in combatting certain forms of cancer (Wang et al., 2003). Peas, especially garden peas (with wrinkled seeds), is very good source of resistant starch (Dostalova et al., 2009). Pea starch makes an excellent low-glycemic ingredient (URL-2). Starch is made up of amylose and amylopectin. Most plants contain about 20-25% amylose. But some, like garden pea starch have 70-80% amylose. Content of resistant starch is related to content of amylose, wich is lower in field pea than in wrinkled pea (Dostalova et al., 2009).

Starch is an important nutrient in terms of both taste and canned in peas. As a result of dissolution of excessive amylose in wrinkled peas, opacity occurs in pot liquor and this is undesirable, especially in Canning (Akçin, 1988).

One of the most important quality criteria and restrictions on the use of the legumes as human food is cooking time. Usually a long time is required to cook of dry legumes, and there is a decrease in the nutritive value of the proteins due to the over-cooking. Cooking causes some physicochemical changes such as gelatinization of the starch and denaturing of the protein in legumes. Cooking also reduces or neutralizes levels of antinutrition material such as trypsin inhibitors and oligosaccharides which causes the gas, so that the nutritive quality of the legumes can be improved (Bishnoi and Khetarpaul, 1993). Factors affecting the cooking quality of legume varieties are seed characteristics, seed composition and the growing environment.

The Near East and the Mediterranean gene centers in which our country is in, is a gene centre for pea as for most plants (Akçin, 1988). Turkey is the place of origin as well as the most important distribution center of wild *Pisum* species (Inal and Toker, 2010). However, despite all of these, the lack of our local varieties for edible is a disadvantage in terms of agriculture.

It is wanted that varieties being developed all agricultural products become as well as highly productive and durable against stres conditions and also more healty, nutritious. Hence, the zeitgest of concentrating on quality-oriented breeding studies has become popular in recent years. Bishnoi and Khetarpaul (1993) emphasized new varieties' physicochemical properties and nourishment qualities should be analyzed completely, before they become widespred.

Our region has suitable ecology for pea cultivation and has the potential of being established and being developed food industry. For this reason, varieties convenient for our region should be developed and agriculture should be done with more modern techniques. Thus, local materials should be put into action. Local pea material was picked and described morphologically in our studies being begun for this purpose. Varieties which are developed in the conclusion of making selection only regarding yieldance and durability factors mostly, cannot become widespread on the market because of not to having high quality. For this reason, this study was carried out because we think that in breeding studies devoted to develop variety, one should begin as determining not only agronomic properties but also quality properties. In this study, it was discussed that local pea material would be breeding material or not as determining its physicochemical properties and this properties' alteration due to cultivation time.

Materials and Methods

This study's material consists of total 48 genotype as 44 line which are obtained from National Plant Gene Bank and picked from Samsun's coastal cities and 4 control varieties (Klein, Green Pearly, Sprinter, Sugar Bon).

The study was conducted in Samsun located in Coastal Middle Black Sea Region in 2009-2010 cultivating season. It is determined that the field sowed in winter, its soil is loamy, its pH is 6.85, a little saline and its organic substance is high; experiment field sowed in early spring, its soil is loamy its pH is 6.89 and non saline it shows average property in terms of organic substance. Totally 541.2 mm rain dropped during vegetation in winter sowing period and 506.8 mm rain dropped during vegetation in early spring sowing period. Other climate data did not differ fom long years averages.

Experiments were arranged in split plot experimental design with three replications. Genotypes were placed in sub parcels and sowing time were placed in main parcels. Genotypes were sowed 50 x 15 cm density on November 13 and February 25. The example was taken from blended and harvested seeds for colour measurement, cooking test, starch and amylose analyses. After dry harvest, seed colour was measured and genotypes were split into groups as dark and light coloured seed, and variance analysis was applied to all groups one by one. SPSS13 software was used for statistic analyses and after that Duncan multiple comparison test was used. In our study, because cooking time and fragmenttion degrees were made as 3 parallelly, variance anaysis was not applied that properties yet with no replication, only their values were given at Tables 1 and 2.

Colour measurement in dry seed: Colour values of randomly selected 30 of dry pea seeds determined as the L* (lightness, 0 = black, 100 = white), a* (+, red; -, green) and b* (+, yellow; -, blue) with Minolta brand colour measurement device (Savage et al., 2001), (URL-3).

Cooking time (minutes): 100 seeds were put in a beaker as 3 replications of each genotype. Later, 100 mL of distilled water was added on seeds, sealed with aluminum foil and keeped in the drying oven at 23°C for 16 h. At the end of 16 h, seeds that not absorb water were recorded as hard seed ratio. Seeds were put in a beaker which is filled with 150 mL of boiling distilled water in heater set to 200°C. After 10 min, samples taken for cooking control, seed hulled and split into two. Then these checks were conducted in every 3 min. When the white spot in the middle of cotyledons were lost the cooking time was recorded as minute (URL-4).

Fragmenttion Degree (%): Fragmented seeds were counted at the seeds determined the cooking time and fragmentation ratio were determined as visually.

Dry matter loss in cooking (%): Seeds were cooked in the times determined in cooking time analysis. After cooling the seeds cooked filtered. Cooking water, diluted to 200 mL with distilled water. So, 8 coefficient was obtained. 25 mL of diluted cooking water was put in beakers with 3 replications. Dried to constant weight in the drying oven at 105°C and the weighed in precision scales (A). Weight measured, proportioned to the previous cooking weight of seeds (B) and calculated as the following equation (Black et al., 1998a).

$$\text{Dry Matter Loss in Cooking} = \frac{A}{B/8} x100$$

Starch rate of seeds (%): 2.5 g of seeds milled were weighed and put into a 100 mL volumetric flask. 50 mL of 1.128% HCl was added and the mouth of volumetric flask is closed with a stopper, shaken and placed in boiling water bath. After 15 min, flask removed from boiling water bath and 30 mL of distilled water is added and quickly cooled to 20°C. At the end of cooling 5 mL of Carrez-I solution was added and after shaking for 1 min 5 mL of Carrez-II solution is added and shaken again for 1 min. Flask were completed with distilled water up to bar line and shaken again. Prepared sample was filtered through blotter and Schleicher& Schuell 5893 Blauband filter paper. Clear filtrate filled into polarimeter tube without air bubbles and value of N is determined on Atago brand POLAX-2L model polarimeter. The N value

Table 1
Colour measurements value in dry seed of pea genotypes

Genotypes	L^*	a^*	b^*	Genotypes	L^*	A^*	b^*
Bz1	24.08	13.39	7.03	Bz25	58.68	2.68	17.94
Bz2	50.01	4.51	22.19	Bz26	61.33	2.79	21.14
Bz3	47.70	7.01	16.09	Bz27	57.62	3.52	21.76
Bz4	49.38	6.08	19.79	Bz28	68.46	1.78	23.73
Bz5	50.95	4.22	21.23	Bz29	61.70	2.76	22.28
Bz6	46.27	4.06	20.45	Bz30	62.16	2.86	22.62
Bz7	50.54	4.25	22.27	Bz31	63.98	2.61	22.45
Bz8	50.41	7.64	22.66	Bz32	66.48	1.65	20.39
Bz9	50.47	4.80	22.19	Bz33	64.11	2.03	20.24
Bz10	45.60	4.07	21.43	Bz34	64.59	2.15	23.06
Bz11	46.68	1.81	17.50	Bz35	63.65	2.81	20.28
Bz12	48.12	5.02	19.92	Bz36	67.26	1.90	22.51
Bz13	46.11	7.48	19.56	Bz37	65.62	2.00	18.44
Bz14	47.72	1.92	19.68	Bz38	65.08	2.46	20.00
Bz15	46.40	7.02	20.27	Bz39	62.58	2.72	25.02
Bz16	42.13	-1.74	17.47	Bz40	63.89	2.76	25.05
Bz17	45.12	-2.04	17.38	Bz41	66.00	1.97	20.20
Bz18	45.54	-2.11	16.39	Bz42	65.03	1.01	19.44
Bz19	42.14	-0.57	16.99	Bz43	64.60	-0.20	28.62
Bz20	50.25	-5.58	22.31	Bz44	69.90	0.18	19.25
Bz21	50.92	-5.55	20.46	Klein	62.80	0.36	20.19
Bz22	50.60	-4.11	21.05	Sugar Bon	67.21	0.53	18.97
Bz23	61.49	3.73	21.56	Sprinter	68.41	0.19	16.17
Bz24	61.38	3.55	20.69	Green Pearly	63.77	0.53	16.34

determined was used in the following formula and % starch was calculated (URL-5).

$$\text{Starch Ratio} = \frac{NX\,2000}{184}$$

Amylose rate in seed (%): After pea seeds were milled and sieved through 100 mesh screen, 0.1 g sample was weighed in 50 mL flask. 1 mL of 95% ethanol and 9 mL of 1N NaOH was added. Erlenmeyer flask was covered with aluminum foil and waited in boiling water bath for 10 min. After cooling the solution taken from the water bath, solution was taken into 100 mL volumetric flask and completed to 100 mL volume with ultrapure water and mixed thoroughly. 5 mL of this starch solution is transferred into a 100 mL volumetric flask. 1 mL of 1 N acetic acid and 2 mL of iodine solution was added and completed to 100 mL with ultrapure water. Allowed to stand for 20 min with shaking thoroughly, the absorbance value was determined at a wavelength of 620 nm in spectrophotometer (T60-UV-VIS). Amylose % value was calculated replacing absorbance value readed in calibration equation drawing with 11 different doses (0, 4, 8, 12, 16, 20, 24, 28, 32, 36, 40 ppm) of standard of amylose (Juliano, 1971).

Results and Discussion

Generally, light-coloured seed type in all legumes is preferred for use purpose of dry seed in Turkey. Dark-coloured seed types for pea are used as crib. After harvest, firstly, the colour of seeds were determined with colorimeter. variance analysis was not applied for values determined with colorimeter, their values were given at Table 1.

L value which gave us information about seed colour darkness changed between 24.08-69.90 at genotypes (Table 1). Being high of L value means that seed is light-coloured. 22 has dark, 22 has light-coloured seed from 44 lines, except control varieties. L value was changed between 24.08-50.95 at dark-coloured seed lines, between 57.62-69.90 at light-coloured seed lines, between 62.80-68.41 at control varieties. Dark-coloured seed is not preferred for use purpose of dry seed because of darkening the cooking water. 14 lines passed the control varieties in terms of L value and it was determined that these lines are yellow and light green. a^* value which gave us information about seed's red and green colour changed between -5.58-13.39 at genotypes (Table 1). This value's positiveness is as high so seed's redness increases, when its negativeness increases, it means that seed's green colour increases. a^* value changed between -5.58-13.39 at dark-coloured seed lines, between - 0.20-3.73 at light-coloured seed lines, between 0.19-0.53 at control varieties. b^* value which gave us information about seed's yellow and blueness changed between 7.03-28.62, 16.17-20.19 at genotypes (Table 1). This value's positiveness is as high so seed's yellowness increases, when its negativeness increases, it means that seed's blue colour increases. b^* value changed between 7.03-22.66 at lines having dark-colour seed, between 17.94-28.62 at lines having light-coloured seed, between 16.17-20.19 at control varieties. L, a^*, and b^* values has no utility in practice, but their variability become a measure of the diffrences of genotypes' colours each other. Singh et al. (2010), determined that L, a^*, and b^* values changed between 43.6-67.1, 2.3-6.2, 5.8-17.4 respectively in their study which they observed 71 field peas' lines properties.

Genotypes were classified into light and dark coloured seed regarding colour measurement values and their variance analyses were applied one by one. In accordance with the conclusion of variance analyses, in terms of hard seed number, dry matter loss in cooking, starch ratios in seed statistical differences ($P < 0.01$) were determined at sowing times, genotypes and between their interactions at genotypes having both dark and light coloured seed (Tables 2 and 3).

Hard Seed Ratio: Legumes are generally soaking before cooking to provide softening, taking uniform water of testa and to provide cooking cotyledon's uniform (Bishnoi and Khetarpaul, 1993). Hard seeds at the end of the soaking are an undesirable property for both use of edible and seed of the product. The ratio of hard seed was determined soaking 100 seeds. The ratio of hard seed is much more at dark-coloured seed lines (24.8%) than light-coloured seed genotypes (3.4%). The ratio of hard seed changed between 1.3-78.7% at dark-coloured seed lines and between 0-9.8% at light-coloured seed genotypes. Hard seed ratio was higher in winter sowing than in early spring sowing at genotypes having both seed colours (Figure 1). There were 10 lines (Bz26, Bz27, Bz29, Bz30, Bz31, Bz33, Bz35, Bz37, Bz42, Bz43) whose hard seed ratio was 2% and less, having light colour seed at the same time. This value was the highest for dark green coloured, small seedy Bz16, Bz17, Bz18, Bz19, Bz20, Bz21, Bz22 lines and these lines placed in the two initial groups (a and b) at the statistic classification. These types are not suggested for intentional edible use. The highness of hard seed ratio will be undesirable situation to be able to use them as feeder because these types are even utilized as green feed or dry pasture, being high of their germination and emergence powers will be wanted. Hard seed is one of the most important reasons of dormancy for grain legumes. Genetic and environmental factors affect the ratio of hard seed (Kantar, 1994). It will be truer hard seed ratio should be interpreted as determining whether it stems from seed's dormancy or from testa, or from seed's organelles. Black et al. (1998b), reported the ratio of hard seed for 23 field peas (*Pisum sativum*) genotypes is high at brown peas tend to gray in Aus-

tralia. Karayel and Bozoğlu (2011), reported the ratio of hard seed was between 2-42% for peas (*Pisum sativum* L.) seeds at different ages; Black et al. (1998a), reported the ratio of hard seed was between 0-43 % for genotypes grown in Australia.

Cooking Time: One of the most important quality criteria for food in field peas is the cooking time in terms of consumer. Due to excessive cooking of the legumes there is a decrease for nutritive value of protein (Bishnoi and Khetarpaul, 1993). Chau et al. (1997) reported that as the cooking time increased, essential amino acid content decrease. For this reason, the legumes with shorter of cooking time is preferred. In our study, cooking time changed between 26-51 min for dark-coloured seed lines, between 19-97 min for light-coloured seed lines, between 42.5-156 min for control varieties. Cooking time for 18 lines having light colour seed was found shorter than control varieties.

In our study, whereas the cooking time for dark-coloured seed lines was shorter in early spring sowing, for light-coloured seed genotypes was shorter in winter sowing. Bishnoi and Khetarpaul (1993), reported the cooking time was changed between 83-106 min for different pea varieties; Black et al. (1998a), reported it as 79-150 min for peas genotypes in Australia; Black et al. (1998b) reported it as 51-180 min for 61 different collection of field pea; Singh et al. (2010) reported it as 45-81 min for 71 field peas lines.

Fragmentation Degree: Besides cooking time, cooked seed's texture is an important quality characteristics of legumes. Wang et al. (2010), reported the sort, the location and the year had an important effect on the cooking time and the durability of cooked pea at their study researched for the effects of the variety and the environment on field pea's (*Pisum sativum*) physico-chemical and cooking properties. In our study, the fragmentation degrees of cooked peas were lower at dark-coloured seed lines (12.1%) than at light-coloured seed genotypes (33.1%). 4 lines had 5% and lower fragmentation degrees and light colour seed were determined. It was found that the fragmentation degrees of cooked peas at genotypes having both dark and light colour seed were lower in early spring sowing than in winter sowing. The reason of this could be that the starch ratio is lower in early spring sowing. The fragmentation degrees of 9 genotypes having light colour seed were 0% in early spring sowing and 3 of them were control varieties, 6 of them were local materials.

Dry Matter Losses at Cooking: The dry matter loss of seed is an undesirable property while cooking because it creates a blur in pot liquor. Therefore this value is desired to be low. Dry matter losses at cooking were more in winter sowing without distinction of color in genotypes (Tables 2 and 3). Because, carbonhydrate in seed accumulates much more in winter sowing and some of them pass the cooking liquor. The dry matter loss at cooking changed between 8.6-12.9% for dark-coloured seed lines, between 7.2-16.5% for light-coloured. The dry matter loss at cooking was determined as 10.9-19.5% for control varieties. It was determined that 14 light seed coloured local lines passed less dry matter to cooking water than control varieties.

A blur occurs in canned water in the conclusion of dissolving amylose at peas having high amylose ratio. This situation is never desired in canned industry (Akçin, 1998). The highest starch but the lowest amylose ratio were found at Klein varieties in winter sowing. Similarly, Sprinter, Sugar Bon ve Green Pearly varieties had the highest dry matter loss at cooking, their amylose ratios in seed were also high. Similar situation was seen for lines. This shows the part passing in cooking water is mostly amylose. For this reason, the relation between the dry matter loss at cooking and amylose ratio in seed was assumed as positive. Line had the highest dry matter loss at cooking is Bz44 line having light-green coloured and

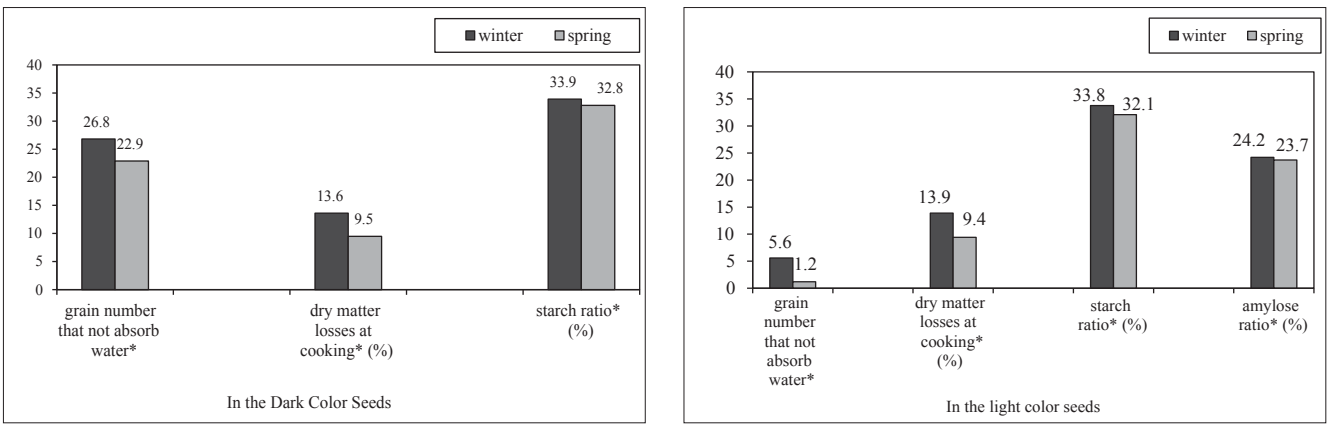

Fig. 1. Dark and light color seed pea genotypes having physical and chemical changes in planting time

Table 2
Average of physical and chemical properties in dark-coloured pea genotypes in sowting time

Genotypes	Bz1	Bz2	Bz3	Bz4	Bz5	Bz6	Bz7	Bz8	Bz9	Bz10	Bz11	Bz12	Bz13	Bz14	Bz15	Bz16	Bz17	Bz18	Bz19	Bz20	Bz21	Bz22	Time Mean
Hard Seed Ratio, %																							
Winter	1.0	3.0	3.3	10.0	7.3	4.7	2.3	6.7	12.3	1.3	5.7	11.3	8.0	8.3	5.3	73.3	51.3	74.3	68.3	80.3	72.7	77.7	26.8 A**
Early Spring	4.7	4.0	1.0	3.0	3.7	4.0	0.3	0.7	5.0	3.7	4.3	4.3	1.0	12.0	5.3	47.0	59.7	68.0	46.0	77.0	73.7	76.3	22.9 B
Mean**	2.8 f-i	3.5 f-i	2.2 hi	6.5 def	5.5 def	4.3 e-h	1.3 i	3.7 f-i	8.7 cd	2.5 ghi	5.0 d-h	7.8 cde	4.5 e-i	10.2 c	5.3 d-g	60.2 b	55.5 b	71.2 a	57.2 b	78.7 a	73.2 a	77.0 a	24.8
Cooking Time, min																							
Winter	64	41	31	40	40	44	46	48	56	49	45	57	61	50	35	32	32	31	39	37	46	50	44.3
Early Spring	30	29	45	42	34	33	32	36	40	25	22	21	41	25	30	25	23	21	18	28	19	32	29.6
Mean	47.0	35.0	38.0	41.0	37.0	38.5	39.0	42.0	48.0	37.0	33.5	39.0	51.0	37.5	32.5	28.5	27.5	26.0	28.5	32.5	32.5	41.0	36.9
Fragmentation Degree, %																							
Winter	5	30	35	30	45	20	20	20	25	5	35	20	20	40	2	40	10	5	10	0	0	0	18.9
Early Spring	0	0	5	3	3	3	0	2	3	0	5	3	20	5	20	30	5	5	3	0	0	0	5.2
Mean	2.5	15.0	20.0	16.5	24.0	11.5	10.0	11.0	14.0	2.5	20.0	11.5	20.0	22.5	11.0	35.0	7.5	5.5	6.5	0.0	0.0	0.0	12.1
Dry Matter Losses at Cooking, %																							
Winter	15.1	11.6	8.1	11.1	11.3	10.8	11.2	13.1	11.2	11.0	11.2	13.9	14.1	17.0	11.6	14.4	13.8	12.5	19.3	18.9	21.4	17.1	13.6 A**
Early Spring	7.1	8.6	9.0	9.1	8.1	8.6	8.5	99.2	9.4	7.2	7.2	6.2	8.3	8.8	8.3	8.9	11.8	12.4	10.9	12.8	14.3	15.0	9.5 B
Mean**	11.1 def	10.1 def	8.6 f	10.1 def	9.7 def	9.7 def	9.9 def	11.2 def	10.3 def	9.1 ef	9.2 def	10.1 def	11.2 def	12.9 bcd	9.9 def	11.7 def	12.8 b-e	12.5 cde	15.1 abc	15.9 abc	17.8 a	16.0 ab	11.6
Starch Ratio at Seed, %																							
Winter	33.9	33.3	32.9	32.8	36.8	35.8	31.7	33.7	34.8	33.7	33.4	33.4	34.1	33.9	30.7	33.7	32.4	36.9	39.9	33.6	33.2	32.3	33.9 A**
Early Spring	32.1	30.2	32.1	33.6	33.4	30.9	30.6	32.7	30.2	31.7	33.4	34.7	33.6	31.0	35.6	32.3	31.8	31.2	31.8	37.9	35.6	355	32.8 B
Mean**	33.0 ef	31.8 h	32.5 g	33.2 e	35.1 b	33.4 e	31.2 i	33.2 e	32.5 g	32.7 fg	33.4 e	34.0 cd	33.9 d	32.5 g	33.2 e	33.0 ef	32.1 h	34.1 cd	35.9 a	35.8 a	34.4 c	33.9 d	33.4
Amylose Ratio at Seed, %																							
Winter	21.3	23.1	24.0	23.8	23.5	23.8	23.1	24.0	23.9	22.9	22.8	23.4	24.1	23.8	24.4	23.2	20.5	22.7	22.9	22.6	20.9	21.6	23.0
Early Spring	21.9	24.9	20.4	21.7	25.9	25.3	24.9	21.8	25.2	25.1	24.5	21.5	23.3	25.2	23.5	20.5	18.7	17.6	26.1	24.7	23.2	22.7	23.1
Mean**	21.6 e	23.9 a	22.2 cde	2.8 bcd	24.7 a	24.6 a	24.0 a	22.9 bc	24.6 a	23.9 a	23.7 ab	22.4 cde	23.7 ab	24.5 a	23.9 a	21.9 de	19.6 f	20.2 f	24.6 a	23.7 ab	22.0 cde	22.2 cde	23.1

**P < 0.01

Table 3
Average of physical and chemical properties in light-coloured pea genotypes in sowing time

Genotypes	Bz23	Bz24	Bz25	Bz26	Bz27	Bz28	Bz29	Bz30	Bz31	Bz32	Bz33	Bz34	Bz35	Bz36	Bz37	Bz38	Bz39	Bz40	Bz41	Bz42	Bz43	Bz44	Klein	Sugar Bon	Sprinter	Green Pearly	Time Mean
Hard Seed Number																											
Winter	3.7	5.7	1.0	0.0	0.7	15.0	4.0	4.0	2.3	19.7	2.0	16.0	1.7	9.7	1.0	6.0	2.0	11.7	9.7	3.7	1.7	17.3	3.0	1.7	2.0	0.3	5.6 A**
Early Spring	6.3	1.0	0.0	0.0	0.7	2.0	0.0	0.0	0.3	0.0	0.3	0.3	0.3	1.7	0.0	0.7	3.0	4.7	0.0	0.0	0.7	0.3	5.7	1.0	2.3	0.0	1.2 B
Mean**	5.0 a-d	3.3 d-g	0.5 ijk	0.0 k	0.7 h-k	8.5 a	2.0 f-k	2.0 f-j	1.3 g-k	9.8 ab	1.2 g-k	8.2 abc	1.0 g-k	5.7 a-d	0.5 ijk	3.3 d-g	2.5 e-h	8.2 a	4.8 c-f	1.8 g-k	1.2 g-k	8.8 ab	4.3 b-e	1.3 g-k	2.2 e-i	0.2 jk	3.4
Cooking Time, min																											
Winter	26	48	36	34	49	33	16	22	31	33	15	31	27	34	34	42	26	20	29	90	90	70	35	106	87	73	43.7
Early Spring	25	34	20	29	38	30	22	29	30	41	28	32	36	41	21	15	21	18	26	104	80	45	50	206	135	122	48.8
Mean	25.5	41.0	28.0	26.5	43.5	31.5	19.0	25.5	30.5	37.0	21.5	31.5	31.5	37.5	27.5	28.5	23.5	19.0	27.5	97.0	85.0	57.5	42.5	156.0	111.0	97.5	46.2
Fragmentation Degree, %																											
Winter	75	75	25	70	70	5	40	10	35	15	40	10	70	15	75	90	80	80	40	5	5	60	80	0	0	3	41.3
Early Spring	70	40	35	10	50	5	50	70	20	0	50	0	50	3	75	50	30	30	0	0	0	0	10	0	0	0	24.9
Mean	72.5	57.5	30.0	40.0	60.0	5.0	45.0	40.0	27.5	7.5	45.0	5.0	60.0	9.0	75.0	70.0	55.0	55.0	20.0	2.5	2.5	30	45.0	0.0	0.0	1.5	33.1
Dry Matter Losses at Cooking, %																											
Winter	9.6	12.9	9.1	9.7	12.8	13.9	10.4	11.9	11.1	11.3	9.7	7.9	11.2	10.9	13.6	15.5	15.7	16.1	8.6	16.8	18.6	25.7	14.1	21.6	22.4	20.8	13.9 A**
Early Spring	9.7	8.6	6.2	6.1	9.9	9.3	8.0	9.3	8.2	8.2	9.2	8.5	7.1	9.9	8.0	6.8	8.0	6.9	5.9	14.9	14.3	7.3	7.8	16.8	16.5	13.5	9.4 B
Mean**	9.7 c-e	10.8 cde	7.6 fg	7.9 fg	11.3 cde	11.6 c	9.2 efg	10.6 cde	9.6 c-e	9.8 c-e	9.5 c-e	8.2 f-g	9.1 efg	10.4 cde		11.2cde	11.8cde	11.5cd	7.2 g	15.8 b	16.5 b	16.5 b	10.9 cde	19.2 a	19.5 a	17.1 b	11.7
Starch Ratio at Seed, %																											
Winter	36.3	38.8	36.3	36.9	37.2	34.4	39.6	34.5	35.1	35.6	34.0	34.3	33.4	35.7	35.4	37.5	38.1	34.9	36.7	23.4	22.4	34.9	34.2	27.8	27.3	24.5	33.8 A**
Early Spring	37.8	38.3	35.0	31.4	35.8	29.9	34.3	33.0	33.4	30.3	32.1	33.4	33.5	33.8	33.6	37.2	32.2	34.0	31.5	24.5	25.3	32.4	34.6	24.0	25.4	26.6	32.1 B
Mean**	37.0 b	38.6 a	35.7 d	34.2 fg	36.5 c	32.1 k	36.9 bc	33.8 ghi	34.2 efg	32.9 j	33.1 j	33.8 ghi	33.4 ij	34.8 e	34.5 ef	37.4 b	35.1 ef	34.5 ef	34.1 fgh	23.9 m	23.9 m	33.6 hi	34.4 ef	25.91	26.4	25.51	32.9
Amylose Ratio at Seed, %																											
Winter	22.0	23.6	22.6	22.4	25.7	24.8	24.2	21.4	24.3	25.2	22.3	23.6	24.6	23.8	23.8	25.3	22.5	23.5	23.8	25.5	25.2	24.9	23.9	27.9	26.9	25.8	24.2A**
Early Spring	24.7	24.5	24.4	23.8	24.9	24.4	23.7	21.0	25.6	21.5	20.6	25.7	22.8	24.4	25.6	23.3	25.9	25.9	18.8	22.1	28.2	20.8	20.9	25.6	23.0	23.6	23.7B
Mean**	23.4 d-h	24.0 b-g	23.5 d-h	23.1 fgh	25.3 b	24.6 b-e	23.9 c-g	21.2 i	24.9 b-c	23.3 e-h	21.4 i	24.6 b-e	23.7 c-g	24.1 b-g	24.7 bcd	24.3 b-f	24.2 b-g	24.7 b-e	21.3 i	23.8 c-g	26.7 a	22.9 gh	22.4 hi	26.8 a	24.9 bc	24.7 b-e	23.9

**P < 0.01

the property of smooth seed, and it is Sprinter from the varieties. Genotypes having the highest and the lowest dry matter loss at cooking reacted differently in winter and early spring sowing. Because these genotypes' dry matter loss at cooking in winter and early spring sowing became different as proportionately, some of them had less some of them more, it caused to appear the significant of their interactions as statistically.

Starch Ratio: Starch contituetes most of the dry matter acumulating in the organs harvested of plants, and this therefore not only as source of calories in the human diet but it can also be regarded as a renewable resource that may be utulized in many industrial applications. Aggarwal et al. (2004), reported edible legumes' seeds components consist of 45-65% starch and USA Northen Crops Institue (URL-2), reported dry pea consists of 43% starch. Wang et al. (2010), reported there were significant differences between varieties and environments in terms of starch content in their study about field pea in Canada. It was found in our study, starch ratio was higher in winter sowing than in early spring sowing and the difference was significant statistically (Figure 1). Starch ratio increased with accumulating of higher amount of organic matter per seed at longer duration depend on stringing out of vegetation period in winter sowing. In addition, Green Pearly, Klein, 10 light-coloured seed and 6 dark-coloured seed local lines gave lower starch ratios in winter sowing in comparison with early spring sowing. This different situation for genotypes resulted from x genotype interaction. The starch ratio was higher for dark-coloured seed (33.4%) lines than light-coloured seed (32.9%) genotypes. The starch ratio per seed was between 31.2-35.9% for dark-coloured seed lines, 23.9-38.6% for light-coloured seed lines, 25.5-34.4% for control varieties. There were open-coloured seed 2 lines (Bz42, Bz43) having lower starch ratios than control varieties in terms of starch ratio of seed. Chavan et al. (1999), determined starch ratio in pea as 34.1 ± 0.06%, Ratnayke et al. (2001) determined starch ratio in seed as 32.7-33.5%. Whereas these studies are similar with our obtained findings, there are study results obtained higher ratios. Thus, Wang and Daun (2004), reported the starch ratio of Canadian field pea was 41.6-49.0% and Tzitzika et al. (2006), reported it as 46%.

Amylose Ratio: The starch composes 15-65% of dry weight for legumes'seeds having a commercial importantance. Amylose and amylopectin ratios in legume's starch are quite variable in and among species. Round pea seeds consist of 37% amylose and wrinkle pea seeds 69% (Norton et al., 1985). Being high amylose ratio in pea is an undesirable situation. However, Dostalova et al. (2009), determined there was a positive and very significant relation between amylose and resistant starch content in pea. Hence resistant starch is extremely important to struggle with some cancer types (Wang et al., 2003). In our study in the conclusion of variation analysis it was determined whereas there was no difference as statistically for dark-coloured seed lines in terms of amylose ratio per seed in sowing times, there were significant differences ($P < 0.01$) for light-coloured seed genotypes in terms of sowing times. Amylose ratio was higher in winter sowing, but it was seen that amylose ratios were higher in 11 lines from light-coloured seed lines in early spring sowing (Table 3).

Reacting of genotypes differently to sowing times lead to appearance of interaction significant as statistically. When decreasing of amylose much more is wanted, it can be sowed in early spring instead of winter. In our study, amylose ratio was determined between 19.6-24.7% for dark-coloured seed lines, 21.2-26.7% for light-coloured seed lines, 22.4-26.8% for control varieties. Amylose ratio was given via starch in seed at some studies. If such a calculation was applied, amylose ratio in starch changed between 61.1-70.3% for dark-coloured seed lines, 62.7-100% for light-coloured seed lines, 65.1-100% for control varieties. Jones et al. (1999), reported smooth seed pea's starch consisted of 0-40% amylose and wrinkle seed pea's starch consisted of 50-100% amylose. Dostalova et al. (2009), reported average of amylose content of pea seed is 27.8% and average of amylose content of starch is 76.82%. Norton et al. (1985) reported 37% and 69% of smooth and wrinkle pea seeds' starches is amylose. The highest ratio of amylose at wrinkle seedy Sugar Bon and the lowest ratio at smooth seedy Klein were determined for control varieties both winter and early spring sowings. Kosson et al. (1994) reported amylose content of in starch was higher for wrinkle pea seeds that has low starch ratio than smooth peas. A similar situation was seen in our study.

Conclusion

22 of materials used in our study has dark colour seed. Being light coloured of seed is preferred because of not darkening the cooking water for use of edible, but only being light coloured of seed does not mean it is suitable for the edible consumption. Hard seed ratio was 2% and less for 10 lines (Bz26, Bz27, Bz29, Bz30, Bz31, Bz33, Bz35, Bz37, Bz42, Bz43) from light-coloured seed 22 lines. 2 lines (Bz42, Bz43) from these 10 lines had the lowest (2.5%) fragmentation degrees after cooked. These two lines' cooking times were not shorter than other lines, but shorter than control lines. For this reason Bz42 and Bz43 lines are suggested as candidate variety to be able to developed for edible. Bz29 ve Bz40 lines had the shortest cooking time (19 min). Both of these two lines are yellow and has the property of smooth seed and are suitable for edible use, but having high fragmentation degrees is undesirable situation at the end of the cooking. So, these lines can

be utilized for crossing studies. Having high amylose ratio for pea is an undesirable situation because it creates a blur in the pot liquor. Light-coloured seed 3 lines (Bz30, Bz33, Bz41) can be utilized as flour not as whole seed since they have low amylose ratio in seed but also they have high fragmentation ratios. Dark-coloured seed Bz19 and Bz20 lines can be utilized as concentrate feed to rich feed's content because of having both high starch ratio and high amylose ratios in seed.

Hard seed ratio, fragmentation degree, the dry matter loss at cooking, starch and amylose ratio in seed were lower in early spring sowing. For this reason, early spring sowing is suggested in terms of seed quality for areas like Samsun as having temperate climate in other words, for areas convenient for both winter and early spring sowings. Winter sowing is suggested for feed cultivation because of being the high starch and amylose ratios in seed and high biomass yield.

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