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Characterization of chemical composition in the lipids from seeds bread of wheat (*T. aestivum* L.)

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Abstract

In this study, chemical components of whole seeds lipids, and extracted lipids in wheat genotypes were analysed and effective and important components in lysine, Zn, B_6 vitamin and the rate of linoleic acid/linolenic that is important for nutritional quality were determined by decision tree analysis. Bread wheat genotypes, Tosunbey, Alpu 01, ES26, Reis, Nacibey, Altay2000, Bayraktar 2000 and Rumeli, were used. The chemical compositions of whole seeds and seed lipids were investigated. The mean rate of components in lipids to total amount of while seed almost ranges between 53-68%. This means that rate in minerals, amino acids, fatty acids-enzymes-vitamins was about 53%, 63 and 68%, respectively. Besides, except for Ca and the rate of linoleic acid/linolenic acid, differences between whole seeds and lipids in genotypes for the other components were determined as significant at 1%. Differences for Ca and the rate of linoleic acid/linolenic acid were insignificant and significant at 5%, respectively. A substantial amount of components is present in wheat lipids. The ratio of these amounts to the whole seed is approximately one-third. Lipids amount and its content composition are important for bread quality. Therefore, consuming whole wheat flour containing embryo and bran provides a better quality nutrition. This rich content of wheat lipids makes it a valuable substance for the cosmetic industry. The results showed that Tosunbey-G1, Alpu 01-G2, ES26-G3 and Nacibey-G5 had the highest nutritional values and better activity. Mn, tryptophan, Na, N and Ca were found as effective components in the shaping and activity of lysine. SOD, Ca, Mg, N, Fe, Na and K were concluded as significant components in Zn activity. Significant components were found in whole seed and lipids such as linoleic, glutamine, N, Na and K for B_6. In linoleic/linolenic rate, linolenic, N, Na were important components.

Key Words: Bread wheat, whole seeds lipids, extracted lipids, biplot, decision tree

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Ekmeklik buğday (*T.aestivum* L.) genotiplerinde tam tohum lipidsleri ve ekstrakte lipids kompozisyonunun karakterizasyonu

Özet

Bu çalışmada, buğday genotiplerinde bulunan tam tohum lipitleri, ekstrakte edilmiş lipitlerin kimyasal bileşenleri analiz edilmiş ve lisin, Zn, B6 vitamini ve besin kalitesi açısından önemli olan linoleik asit/linolenik oranında etkili ve önemli bileşenler karar ağacı analizi ile belirlenmiştir. Ekmeklik buğday genotiplerinden Tosunbey, Alpu 01, ES26, Reis, Nacibey, Altay2000, Bayraktar 2000 ve Rumeli kullanılmıştır. Bütün tohumların ve tohum lipitlerinin kimyasal bileşimleri araştırılmıştır. Lipidslerdeki bileşenlerin toplam miktara oranı ortalama %53-68 arasında değişmektedir. Yani mineraller, amino asitler, yağ asitleri-enzimler-vitaminlerdeki oran sırasıyla %53, %63 ve %68 civarında bulunmuştur. Ayrıca Ca ve linoleik asit/linolenik asit oranı dışında diğer bileşenler açısından bütün tohumlar ve lipitler arasında genotiplerdeki farklılıklar %1 düzeyinde önemli bulunmuştur. Ca ve linoleik asit/linolenik

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asit oranı arasındaki farklar sırasıyla önemsiz ve %5 düzeyinde öenmli olmuştur. Buğday lipidsinde önemli miktarda bileşen mevcuttur. Bu miktarların tohumun tamamına oranı yaklaşık üçte birdir. Ekmeğin kalitesi açısından lipit miktarı ve içeriğinin bileşimi önemlidir. Bu nedenle embriyo ve kepek içeren tam buğday ununun tüketilmesi önerilmektedir. Buğday lipidsinin bu zengin içeriği, onu kozmetik endüstrisi için değerli bir madde haline getirmektedir. Sonuçlar Tosunbey-G1, Alpu 01-G2, ES26-G3 ve Nacibey-G5'in en yüksek besin değerlerine ve daha iyi aktiviteye sahip olduğunu göstermiştir. Lisinin şekillenmesinde ve aktivitesinde Mn, triptofan, Na, N ve Ca etkili bileşenler olarak tespit edilirken, SOD, Ca, Mg, N, Fe, Na ve K'nın Zn aktivitesinde önemli bileşenler olduğu sonucuna ulaşılmıştır. Bütün tohum ve lipidsde B_6 için linoleik, glutamin, N, Na ve K gibi önemli bileşenler bulunmuştur. Linoleik/linolenik oranında ise linolenik, N, Na önemli bileşenlerdir.

Anahtar Kelimeler: Ekmeklik buğday, tam tohum lipidsi, ekstrakte edilmiş lipids, biplot, karar ağacı,

1. Introduction

Wheat is one of the basic products that people use as flour, bread, biscuits and pasta.almost 50% of the calorie needs of the world's people are met from plant-based products (44% of which comes from bread alone) and 77% of the protein needs are met from plant-based products. Considering that, the approximate share of animal foods in providing daily calories is 20% and that animals are mostly fed with plant feeds; it is understood that humanity provides approximately 3/4 of its daily nutrition from grains. Wheat is showing itself as a plant that is becoming more and more important in terms of nutrition, nutrition and the future of humanity in the world. The gradual increase in terms of cultivation area and production amount is an indication of the increasing importance given to wheat. Among grains, wheat plays an important role in human nutrition and is a rich source not only of carbohydrates but also of proteins, amino acids, minerals, lipids, vitamins and dietary fibre [1]. In general, wheat flour contains 70% starch, 2% lipids, 2% pentosane, 12% protein and 12% moisture [2]. In this context, wheat lipids, minerals, amino acids and other components are mostly found in the embryo and bran. Wheat lipids, cell membranes, organelles and spherosomes are the source of wheat lipids. Depending on the degree of milling in wheat flour, the amount of lipids varies by 0.5% to 3% due to the mixing of other grain parts into the endosperm. The embryo has the highest lipids amount in wheat grain (11%). The bran layer also carries a significant amount of lipids [3]. The most abundant fatty acids in wheat are C16:0 (palmitic acid) and C18;0 (stearic acid), C18:1 (oleic acid), C18:2 (linoleic acid) and C18:3 (linolenic acid) [4]. Because of the binding of free glycolipids to gluten and gliadin in wheat flour, the gas retention property of gluten is improved. The complex structure of galacto lipids with starch is important in preserving the freshness of bread. The gas holding power of the dough is improved by closing the gas cells in the dough in the structure formed by the interaction of lipids with gluten and starch. Unsaturated lipids have very important functions in the oxidation of flours and thus improving the viscoelastic properties of dough. Unsaturated lipids, especially linoleic and linolenic acid, combine with atmospheric oxygen and undergo rapid oxidation through the lipoxidase enzyme. Hydro peroxides formed as a result of the oxidation of unsaturated lipids then oxidize sulfhydryl groups to disulphide groups [5]. Wheat lipids have significant potential in both plant growth, product quality and industrial fields (cosmetics). Wheat lipids is widely used in the pharmaceutical and cosmetic industries [6], as well as food, feed and biological insect control agent, and for the production of vitamin E [7]. Since, wheat lipids are located especially in the embryo layer; they contain significant amounts of vitamin E (tocopherol), antioxidants, carotenoids (vitamin A) [7]. Because it is dense in the embryo, it is rich and balanced in terms of B group vitamins (such as B1, B2, B6) [6], protein (mostly albumin and globulin) and therefore essential amino acids. Acid profile (especially lysine) [8], mineral substances such as potassium, magnesium, calcium, zinc and manganese [8], fibre, pentosane, sugars, antioxidant components [7]. As a result, wheat lipids, with the amino acids, unsaturated fatty acids, vitamins, mineral substances and antioxidant components they contain, are a very valuable product in terms of improving dough properties, nutrition, agriculture and the cosmetic industry. In this study, chemical components of whole seeds and lipids, extracted in wheat genotypes were analysed and effective and important components in lysine, Zn, B_6 vitamin and the rate of linoleic acid/linolenic that is important for nutritional quality were determined by decision tree analysis.

2. Material and method

Study was conducted in laboratory conditions of Eskisehir Osmangazi University, faculty of Agriculture in 2022. Bread wheat genotypes, Tosunbey, Alpu 01, ES26, Reis, Nacibey, Altay2000, Bayraktar 2000 and Rumeli, were used. Plant characteristics of bread wheat genotypes were given in Table 1.

Table 1. Plant characteristics of bread wheat genotypes

1 Tosunbey	**Spike characteristics;** brown awned, hard white grain; **agricultural features;** plant height, 100-110 cm, winter habit, mod-late, lodging resistant; **quality characteristics;** thousand seed weight, 38-42 g, test weight, 82-85 kg, protein, 13-14%, sedimentation 50-66 ml; **resistance to stress conditions;** resistant to yellow rust, brown rust, resistant to cold and drought.
2 Alpu 01	**Spike characteristics;** white awned, soft white grain; **agricultural features;** plant height, 90-100 cm, winter habit, mod-late, lodging resistant; **quality characteristics;** thousand seed weight, 40-44 g, test weight, 80-84 kg, protein, 10-11,5%, sedimentation 40-48 ml; **resistance to stress conditions;** resistant to yellow rust, brown rust, resistant to cold and drought.
3 ES26	**Spike characteristics;** brown awned, semi-hard white grain; **agricultural features;** plant height, 105-115 cm, winter habit, early, lodging resistant; **quality characteristics;** thousand seed weight, 37-38 g, test weight, 79-80 kg, protein, 10-12%, sedimentation 42-43 ml; **resistance to stress conditions;** resistant to yellow rust, brown rust, resistant to cold and drought.
4 Reis	**Spike characteristics;** brown awned, hard red grain; **agricultural features;** plant height, 105-110 cm, winter habit, early, lodging resistant; **quality characteristics;** thousand seed weight, 34-37 g, test weight, 77-79 kg, protein, 10-12%, sedimentation 43-46 ml; **resistance to stress conditions;** resistant to yellow rust, brown rust, resistant to cold and drought.
5 Nacibey	**Spike characteristics;** white awned, semi-hard red grain; **agricultural features;** plant height, 105-110 cm, winter habit, mod-late, lodging resistant; **quality characteristics;** thousand seed weight, 36-38 g, test weight, 76-78 kg, protein, 11-13%, sedimentation 46-48 ml; **resistance to stress conditions;** resistant to yellow rust, brown rust, resistant to cold and drought.
6 Altay2000	**Spike characteristics;** brown awned, semi-hard white grain; **agricultural features;** plant height, 100-110 cm, winter habit, mod-late, lodging resistant; **quality characteristics;** thousand seed weight, 32-34 g, test weight, 80-82 kg, protein, 11-12%, sedimentation 54-56 ml; **resistance to stress conditions;** resistant to yellow rust, brown rust, resistant to cold and drought.
7Bayraktar2000	**Spike characteristics;** white awned, semi-hard white grain; **agricultural features;** plant height, 90-100 cm, winter habit, early, lodging resistant; **quality characteristics;** thousand seed weight, 36-40 g, test weight, 78-80 kg, protein, 11-13%, sedimentation 48-52 ml; **resistance to stress conditions;** resistant to yellow rust, brown rust, resistant to cold and drought.
8 Rumeli	**Spike characteristics;** white awned, hard red grain; **agricultural features;** plant height, 100-110 cm, winter habit, mod-late, lodging resistant; **quality characteristics;** thousand seed weight, 44-46 g, test weight, 82-84 kg, protein, 13-15%, sedimentation 58-65 ml; **resistance to stress conditions;** resistant to yellow rust, brown rust, resistant to cold and drought.

The abbreviations of the genotypes used in the experiment based on the whole seed and seed lipids are given below; **Whole seed;** Tosunbey-**Seed G_1**, Alpu 01- **Seed G_2**, ES26 **Seed G_3**, Reis **Seed G_4**, Nacibey **Seed G_5**, Altay2000 **Seed G_6**, Bayraktar 2000 **Seed G_7** and Rumeli **Seed G_8**. **Seed Lipids;** Tosunbey-**Lipids G_1**, Alpu 01- **Lipids G_2**, ES26 **Lipids G_3**, Reis **Lipids G_4**, Nacibey **Lipids G_5**, Altay2000 **Lipids G_6**, Bayraktar 2000 **Lipids G_7** and Rumeli **Lipids G_8**

Chemical compositions of whole seed and seed lipids were investigated. Soxhlet Apparatus was used to extract seed lipids from wheat genotypes using a with petroleum ether for 5 h. The ether solvent was removed in a rotary vacuum evaporator at 50 °C, reckoned as % [9]. Methods of [10], for amino acid analysis, [11] for mineral analysis, [12] for A vitamin analysis, [13] for Vitamin C analysis, [14] for B_6 vitamin analysis, [23] for lipids acids analysis, [15, 24] for enzymes analysis were made. The changes on data of wheat genotypes were examined by t test and biplot [16], decision tree analyses [17] in Minitab 17, SPSS 25 programs.

3. Results

Wheat is one of the most grown cereals in the world due to its genetic value, carbohydrate content and wide adaptability; Many products are produced, especially bread, bulgur and pasta. Wheat, due to its widespread consumption feature; people meet their needs for many nutritional elements from wheat products in their daily diet. This feature increases the nutritional importance of bread wheat.

3. 1. Content analysis of bread wheat embryo and wheat lipids

When it comes to nutrition, which is an indicator of quality in wheat, the important factors that come to mind are protein ratio and sedimentation rate. In addition, minerals, amino and organic acids, saturated and unsaturated fatty acids, etc. Factors such as these are also factors that affect quality. These elements are mostly in the embryo and bran and are dispersed throughout the grain [18]. At the same time, wheat lipids contains minerals, amino and organic acids, saturated and unsaturated fatty acids, vitamins, etc. Elements such as are present in a certain amount [18]. Wheat lipids is mostly found in the embryo [19]. Wheat lipids, which has a rich content, has important functions in plant metabolism, in the formation and execution of biochemical events necessary for embryonisation, growth, maturation and seed formation, and in the formation of amino acids. Although the embryo and bran are actually the most functional parts of wheat; When it is ground with wheat, the unsaturated fatty acids it contains will darken in colour and taste bitter if it comes into contact with air. This is an indication that wheat lipids has a rich structure in terms of saturated and unsaturated fatty acids, amino and organic acids and vitamins [19].

Table 2. Chemical contents of whole seeds and wheat lipids in bread wheat genotypes

Gen.N.	N (%)	Na (mg/kg)	K (mg/kg)	Ca (mg/kg)	Mg (mg/kg)	P (mg/kg)	Fe (mg/kg)	Cu (mg/kg)	Mn (mg/kg)	Zn (mg/kg)	Asparagine pmolµL^{-1}
Whole Seed											
Seed G$_1$	1,97	180,79	7496,20	5103,91	2238,18	5942,97	151,64	23,53	28,47	**39,23**	10541,78
Seed G$_2$	2,00	177,98	**7747,86**	5024,52	2419,91	5730,01	**156,50**	21,37	29,43	36,36	11385,12
Seed G$_3$	1,90	208,13	7696,50	**5474,22**	2357,21	5636,99	149,75	27,96	**32,96**	33,82	**11726,67**
Seed G$_4$	1,79	**212,54**	7370,27	5395,33	2261,70	5821,24	131,83	**30,04**	29,91	32,81	10024,59
Seed G$_5$	1,86	209,25	7617,69	5311,46	2445,38	**6210,50**	136,19	27,14	30,91	37,74	10325,33
Seed G$_6$	1,92	200,54	7569,23	5123,65	2345,69	6152,36	149,65	29,65	28,96	39,12	10532,41
Seed G$_7$	1,88	199,89	7654,12	5214,89	**2445,65**	5896,74	150,63	27,45	29,65	36,54	10258,23
Seed G$_8$	**2,01**	204,48	7701,23	5301,26	2348,96	5963,41	148,74	25,62	27,98	37,25	10789,54
Mean	**1,92**	**199,20**	**7606,64**	**5243,66**	**2357,83**	**5919,28**	**146,87**	**26,60**	**29,78**	**36,61**	**10697.96**
б	**0,07**	**12,14**	**116,62**	**144,42**	**73,33**	**182,78**	**7,82**	**2,78**	**1,46**	**2,16**	**545.01**
Whole Seed											
Lipids G$_1$	0,82	176,34	4336,62	5220,69	634,94	2701,41	20,57	7,51	**9,51**	17,58	9583,04
Lipids G$_2$	0,77	**178,83**	4074,74	**5536,02**	632,05	**2886,04**	18,90	**8,10**	8,30	18,06	**9711,28**
Lipids G$_3$	0,88	174,27	4371,56	4939,72	638,20	2590,63	20,87	6,99	9,46	20,06	9241,08
Lipids G$_4$	0,94	172,61	4270,11	5113,94	659,17	2836,42	22,13	7,00	8,97	21,23	8685,38
Lipids G$_5$	**1,92**	175,93	4253,21	4725,00	**666,04**	2708,33	**22,34**	6,16	8,96	**21,79**	9027,35
Lipids G$_6$	1,23	173,64	4251,89	5256,12	654,12	2754,89	19,54	6,98	8,99	18,95	9623,45
Lipids G$_7$	0,98	174,56	**4398,25**	5015,14	652,14	2756,89	20,01	7,89	9,12	19,54	9548,63
Lipids G$_8$	1,02	171,69	4184,51	5263,74	661,63	2841,12	21,05	8,01	8,56	18,96	9654,23
Mean	**1,07**	**174,73**	**4267,61**	**5133,80**	**649,79**	**2759,47**	**20,68**	**7,33**	**8,98**	**19,52**	**9384,31**
Б	**0,35**	**2,12**	**98,23**	**229,25**	**12,18**	**88,83**	**1,12**	**0,62**	**0,38**	**1,36**	**342,76**
(Lipids/Seed)*100	**55,73**	**87,72**	**56,10**	**97,90**	**27,56**	**46,62**	**14,08**	**27,56**	**30,15**	**53,32**	**87,72**
t test	**5,93****	**4,69****	**50,93****	**0,85ns**	**62,60****	**41,45****	**37,84****	**16,02****	**40,47****	**14,67****	**6,64****

Gen.N.	Glutamine pmolµL^{-1}	Glycine pmolµL^{-1}	Valine pmolµL^{-1}	Methionine pmolµL^{-1}	Tryptophan pmolµL^{-1}	Phenylalanine pmolµL^{-1}	Lysine pmolµL^{-1}	Hydroxyproline pmolµL^{-1}	Proline pmolµL^{-1}	Cystine pmolµL^{-1}
Whole Seed										
Seed G$_1$	11796,02	3662,67	1069,59	2253,65	2022,76	1979,34	5014,47	2024,73	128,75	772,72
Seed G$_2$	11088,26	3711,73	**1083,92**	**2283,83**	**2049,85**	**2005,85**	5081,62	**2051,85**	**130,47**	741,31
Seed G$_3$	11642,67	3531,86	1031,39	2173,16	1950,52	1908,65	4835,38	1952,42	124,15	765,74
Seed G$_4$	12105,68	3319,30	969,32	2042,37	1833,12	1793,78	4544,36	1834,91	116,68	773,55
Seed G$_5$	**12710,96**	3450,11	1007,52	2122,86	1905,37	1864,47	4723,45	1907,22	121,27	**783,75**
Seed G$_6$	11568,23	**3789,12**	1012,31	2222,41	1958,12	1900,32	5021,47	2012,45	124,56	771,65
Seed G$_7$	12569,41	3698,10	1029,00	2021,45	1987,45	1887,45	**5096,21**	2013,69	122,56	772,58
Seed G$_8$	12111,56	3654,47	1022,36	2012,69	1899,32	1965,23	5045,77	1989,65	124,78	770,23
Mean	**11949,10**	**3602,17**	**1028,18**	**2141,55**	**1950,81**	**1913,14**	**4920,34**	**1973,37**	**124,15**	**768,94**
б	**502,44**	**146,05**	**33,56**	**100,97**	**66,09**	**64,37**	**186,78**	**67,27**	**4,00**	**11,46**
Seed Lipids										
Lipids G$_1$	9020,87	511,44	710,87	1366,76	1833,65	1350,45	2397,09	1113,85	82,54	592,58
Lipids G$_2$	**9141,60**	543,26	767,24	**1407,57**	1724,01	1296,68	2290,46	**1211,65**	79,48	567,17
Lipids G$_3$	8698,92	**586,22**	**790,07**	1323,49	1809,89	1245,07	**2492,15**	1079,06	84,10	605,60
Lipids G$_4$	8175,75	473,03	694,24	1262,45	1735,04	**1376,76**	2254,09	1172,87	85,96	579,41
Lipids G$_5$	8497,70	510,37	714,88	1187,08	1821,48	1321,94	2452,57	1044,55	90,98	**618,61**
Lipids G$_6$	8563,45	489,56	741,23	1365,14	1789,63	1296,32	2356,41	1145,65	**91,65**	612,47
Lipids G$_7$	8674,13	500,11	699,26	1223,45	**1899,41**	1356,89	2357,14	1056,32	89,56	609,45
Lipids G$_8$	8769,49	517,82	715,63	1456,89	1756,32	1354,87	2436,65	1045,96	87,90	596,32
Mean	**8692,74**	**516,48**	**729,18**	**1324,10**	**1796,18**	**1324,87**	**2379,57**	**1108,74**	**86,52**	**597,70**
б	**282,28**	**32,65**	**31,90**	**87,19**	**54,16**	**40,71**	**76,07**	**58,93**	**4,01**	**16,40**
(Lipids/Seed)*100	**72,75**	**14,34**	**70,92**	**61,83**	**92,07**	**69,25**	**48,36**	**56,19**	**69,69**	**77,73**
t test	**12,35****	**55,95****	**22,83****	**19,83****	**5,54****	**18,37****	**34,56****	**26,70****	**14,01****	**40,71****

Gen.N.	Oleic mg/100g	Linolenic mg/100g	Linoleic mg/100g	CAT EU g/leave	POD IU/mg	SOD IU/mg	Avit mg/kg	B$_6$vit mg/kg	Cvit mg/kg	Linoleic/Linolenic
Whole Seed										
Seed G$_1$	46,32	39,70	146,75	3,96	6,16	**6,87**	**29,99**	**40,52**	5,61	3,70
Seed G$_2$	44,99	34,37	150,09	4,01	5,82	6,61	27,19	39,16	5,45	4,38
Seed G$_3$	**54,17**	38,36	144,09	4,10	5,82	5,94	29,42	37,30	5,19	3,76
Seed G$_4$	43,87	**43,15**	150,22	3,38	5,72	6,09	26,59	38,90	5,53	3,48
Seed G$_5$	41,05	34,74	151,9	3,99	**6,22**	6,15	28,46	35,81	5,51	**4,37**
Seed G$_6$	45,69	39,13	**152,47**	3,89	5,96	6,59	29,65	36,00	5,21	3,90
Seed G$_7$	43,58	40,05	151,26	**4,02**	6,12	6,47	29,74	35,87	**5,71**	3,78
Seed G$_8$	52,63	43,06	151,74	3,95	6,14	6,52	28,96	35,96	5,62	3,52
Mean	**46,54**	**39,07**	**149,82**	**3,91**	**6,00**	**6,40**	**28,75**	**37,44**	**5,48**	**3,83**
б	**4,25**	**2,89**	**2,57**	**0,21**	**0,18**	**0,29**	**1,17**	**1,73**	**0,18**	**0,30**
Seed Lipids										
Lipids G$_1$	31,23	**34,67**	**118,21**	2,22	**3,69**	3,86	16,45	25,65	3,07	3,41
Lipids G$_2$	33,90	22,23	117,14	**2,47**	3,65	3,90	16,65	**26,29**	3,13	5,27
Lipids G$_3$	**36,08**	21,72	106,9	2,26	3,60	3,93	16,88	25,93	3,18	4,92
Lipids G$_4$	29,78	18,66	111,33	2,04	3,53	3,78	17,05	22,89	3,19	**5,97**
Lipids G$_5$	31,96	21,02	112,17	2,20	3,65	3,84	17,42	23,24	3,42	5,34
Lipids G$_6$	35,32	19,54	114,25	2,20	3,64	3,89	17,02	23,65	3,12	5,85
Lipids G$_7$	34,56	20,94	115,13	2,21	3,62	3,78	16,98	24,56	3,48	5,50
Lipids G$_8$	33,36	33,79	117,07	2,19	3,67	**3,95**	**17,62**	26,12	**3,69**	3,46
Mean	**33,27**	**22,98**	**114,03**	**2,22**	**3,63**	**3,87**	**17,01**	**24,79**	**3,29**	**4,96**
б	**2,01**	**5,63**	**3,32**	**0,11**	**0,05**	**0,06**	**0,35**	**1,29**	**0,20**	**0,88**
(Lipids/Seed)*100	**71,68**	**86,49**	**78,14**	**56,01**	**61,17**	**61,72**	**61,29**	**69,76**	**67,34**	
t test	**9,38****	**6,80****	**27,48****	**28,31****	**42,41****	**22,95****	**24,71****	**17,99****	**30,84****	**-3,27***

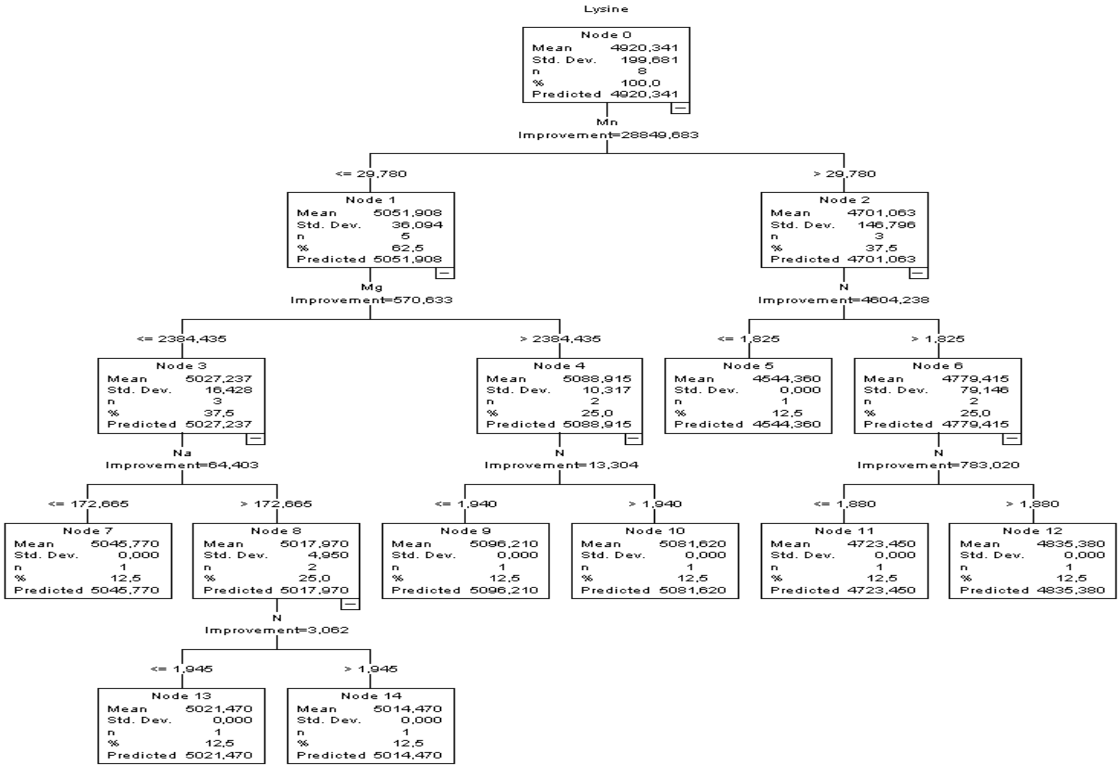
As seen in Table 2, whole seed and Lipids genotypes, having the highest values; **Seed G_1;** N, Zn, A vitamin, SOD and B_6 vitamin. **Seed G_2;** K, Fe, valine, methionine, tryptophan, phenylalanine, hydroxyl proline and proline. **Seed G_3;** Ca, Mn, asparagine and oleic acid. **Seed G_4;** Na, Cu, linolenic acid. **Seed G_5;** P, Mn, glutamine, cysteine, POD, linoleic acid/linolenic acid. **Seed G_6;** glycine, linoleic acid. **Seed G_7;** Mg, lysine, CAT and C vitamin.
Lipids G_1; Mn, linolenic acid, linoleic acid and POD. **Lipids G_2;** Na, Ca, P, Cu, asparagine, glutamine, methionine, hydroxyl proline, CAT, B_6 vitamin. **Lipids G_3;** glycine, valine, lysine and oleic acid. **Lipids G_4;** phenylalanine and linoleic acid/linolenic acid. **Lipids G_5;** N, Mg, Fe, Zn and cysteine. **Lipids G_6;** proline. **Lipids G_7;** K and tryptophan. **Lipids G_8;** A vitamin, SOD and C vitamin. **Seed G_1**, **Seed G_2**, **Seed G_3**, **Seed G_5**, **Seed G_7**, **Lipids G_1**, **Lipids G_2**, **Lipids G_3**, **Lipids G_4**, **Lipids G_5** and **Lipids G_8** showed better performance. Tosunbey-**G_1**, Alpu 01-**G_2**, ES26-**G_3** and Nacibey-**G_5** had the highest values and better activities. Table 2 showed that mean rate of components in lipids to total amount of while seed almost ranges between 53-68%. This mean that rate in minerals, amino acids, fatty acids-enzymes-vitamins was about 53%, 63 and 68%, respectively. Besides, except Ca and the rate of linoleic acid/linolenic acid, differences between whole seeds and lipids in genotypes for the other components were determined as significant at 1%. Differences for Ca and the rate of linoleic acid/linolenic acid were insignificant and significant at 5%, respectively. A substantial amount of components is present in wheat lipids. The ratio of these amounts to the whole seed is approximately one third. This result explains why wheat embryo lipids is widely used as a raw material in cosmetics, medicinal and aromatic fields and in other industrial fields. Wheat lipids, in addition to its cell regenerative feature, is very beneficial for burns, spots and wrinkles on the skin. Although it is effective in various hair problems; this lipids is also very effective for acne and skin dryness [19-20]. In this respect, it has an important place in the cosmetic industry. Besides, the fact that wheat lipids has a rich content in amino acids, minerals, enzymes and vitamins is an indication that this lipids contributes significantly to the biochemical processes in the plant, plant development, and seed quality. In fact, the amino acids, minerals, enzymes and vitamins contained in the seed have vital importance in the embryonisation and development of the plant in the early period, and in the accumulation of dry matter in the later periods. In particular, it has an important effect on the formation of protein and carbohydrates. This situation does not only provide high yield, but also plays an important role in seed quality and in resistance of stress conditions [20].

3. 2. Certain components, affecting nutritional quality

The substance composition of a seed and the amount of these components are important components that reveal the quality level and nutritional value of the seed. There are certain components in wheat seed that are considered in terms of nutritional quality. Lysine, Zn, B_6 vitamin and the rate of linoleic acid/linolenic are known as essential components, making nutritional quality better [20].

3. 3. Lysine

Lysine is an essential amino acid that cannot be synthesized in the human body and must be obtained from external sources. Lysine, whose chemical formula is C6H14N2O2, has two separate isomers [21] as L-Lysine and D-Lysine. The average daily amount of lysine required is between 800 mg and 3,000 mg. It especially helps the absorption of calcium and helps build muscle proteins. It helps protect bones and tissues thanks to calcium absorption. Lysine is an important amino acid that has many benefits such as reducing cold sores and anxiety, tissue repair and anti-aging. Without enough lysine, absorption of vitamins is reduced and collagen formation is inhibited. It also takes part in the synthesis of enzymes, hormones and antibodies [21]. Lysine, which has a direct effect on metabolic events that play a vital role in plant development, health and defence mechanism, takes part in protein synthesis [21], one of the basic building blocks in the plant. At the same time, the high/low amount of lysine in the flour obtained from the seeds helps determine the nutritional quality of that genotype. Decision tree analyses performed overall seed and extracted lipids in order to determine the factors affecting lysine are given in Figure 1 and Figure 2.



Main predictor is Mn;

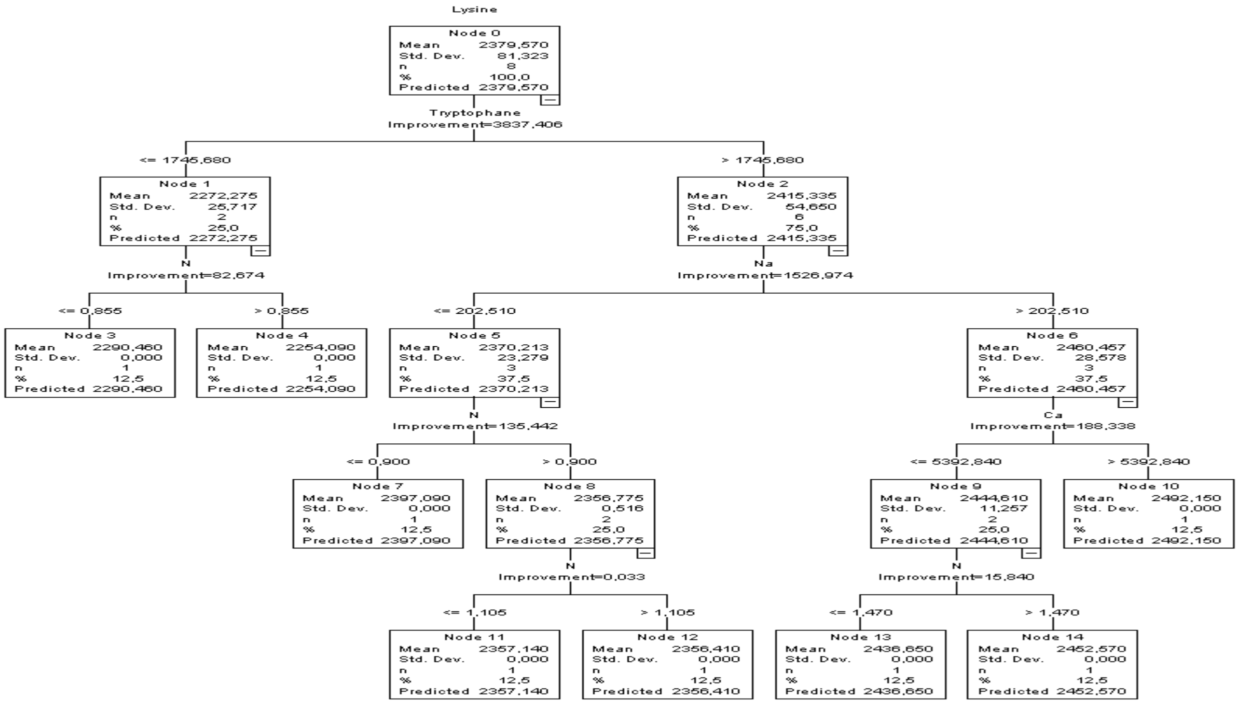
if Mn≤29,780 Lysine is 5051,908
Main predictor is Mg
if Mg≤2384,435 Lysine is 5027,237
Main predictor is Na
if Na≤172,665 Lysine is 5045,770
if Na>172,665 Lysine is 5017,970
Main predictor is N
if N≤1,945 Lysine is 5021,470
if N>1,945 Lysine is 5014,470
if Mg≤2384,435 Lysine is 5088,915
Main predictor is N
if N≤1,940 Lysine is 5096,210
if N>1,940 Lysine is 5081,620

if Mn≤29,780 Lysine is 4701,063
Main predictor is N
if N≤1,825 Lysine is 4544,360
if N>1,945 Lysine is 4779,415
Main predictor is N
if N≤1,880 Lysine is 4723,450
if N>1,880 Lysine is 4835,380

R^2: [1- $\frac{Risk\ Estimation}{62}$]: [1- $\frac{9835,45}{39872,51}$]: 1-0,25: 0,75

Figure 1. Decision tree analysis to determine the factors affecting lysine on whole seed in wheat.

Decision tree analysis denoted that main predictor was Mn and sub predictors were Mg, Na and N in whole seed analysis. Increase in Mn made lysine level increase. Increasing Mg level caused decrease in lysine. Na was another main sub factor in low Mn levels. Higher Na levels decreased lysine levels. Besides, higher N contents had positive effect to lysine. Under higher Mn levels, increasing N contents raised lysine amount. Therefore, Mn, Na and N were determined as important components, effective in lysine (Figure 1). In lipids analysis, tryptophan as the main predictor; N, Ca and Na sub predictors, were found. Once tryptophan dropped off, Lysine amount raised. In lower tryptophan levels, higher Na and N levels caused decline in lysine content. On the contrary, at high tryptophan values, increasing amounts of nitrogen increased the lysine concentration. The major shaping of lysine concentration was possible in the presence of tryptophan, Ca, Na and N (Figure 2). So, Mn, tryptophan, Na, N and Ca were found as effective components in the formation and activity of lysine.



Main predictor is Tryptophan;

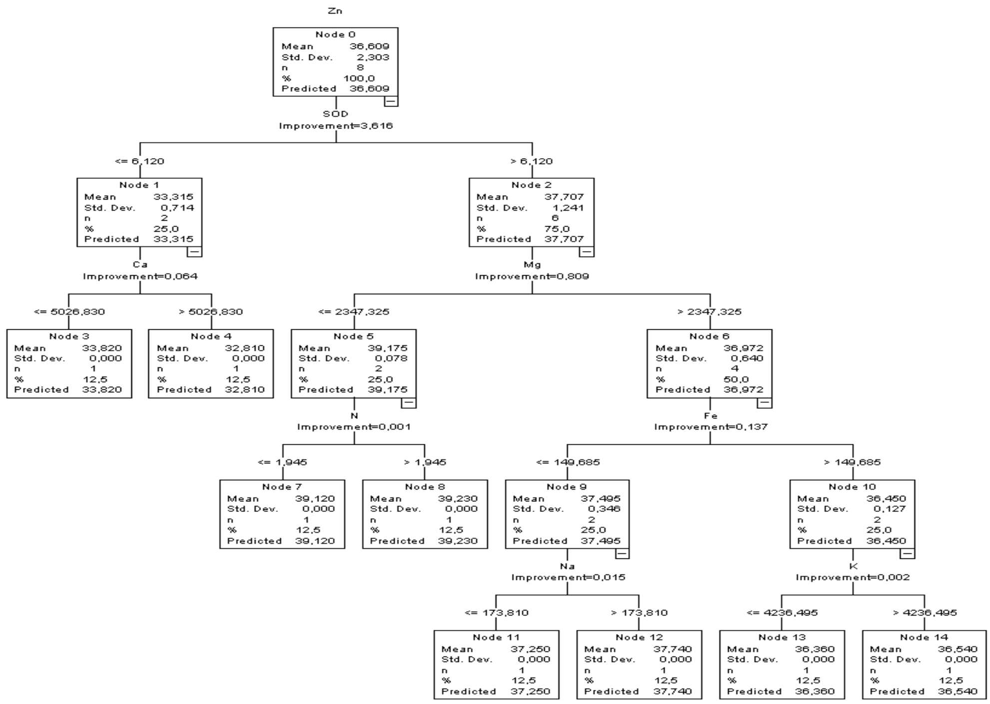
if Tryptophane≤1745,680 Lysine is 2272,275 if Tryptophane≤1745,680 Lysine is 2415,335
Main predictor is N Main predictor is Na
if N≤0,855 Lysine is 2290,460 if Na≤202,510 Lysine is 2370,513 if Na>202,510 Lysine is 2370,513
if N>0,855 Lysine is 2254,090 Main predictor is N Main predictor is Ca
if N≤0,900 Lysine is 2397,090 if N>0,900 Lysine is 2356,775 if Ca≤5392,840 Lysine is 2444,610 if Ca>5392,840 Lysine is 2492,150
Main predictor is N Main predictor is N
if N≤1,105 Lysine is 2357,140 if N≤1,470 Lysine is 2436,650
if N>1,105 Lysine is 2460,457 if N>1,470 Lysine is 2452,570

R^2: [1- $\frac{\text{Risk Estimation}}{S^2}$: [1- $\frac{1468,45}{6613,43}$]: 1-0,22: 0,78

Figure 2. Decision tree analysis performed to determine the factors affecting lysine in the lipids extracted from wheat embryo

3. 4. Zn

Zinc is one of the most important minerals necessary for both human and plant health. One of the most important minerals that benefit the healthy functioning of the human body is zinc. Zinc is a mineral that undertakes many important functions such as the immune system and metabolic activities. In addition, zinc is involved in many activities such as growth, development, protein synthesis, immune system function, reproductive health, tissue formation, and neurobehavioral development. It is predominantly found in muscle, skin, hair, and bone [22]. Zinc, which plays an important role in many biological and physiological processes, should be taken in sufficient amounts for a strong nervous system and immune system. The amount of zinc people need daily under normal conditions is; it is determined as 5 mg in infants, 10 mg to 15 mg in children, and 12 mg to 15 mg in adults [22]. On the other hand, although Zinc is involved in various metabolic events in plants, it plays a role in carbohydrate synthesis, the structure of enzymes, membrane stability, protein synthesis in photosynthesis and respiration [22]. Since, zinc is important in protein synthesis, the high protein content in the flour, combined with a high zinc level, indicates a high-quality variety. Decision tree analyses performed overall seed and extracted lipids in order to determine the factors affecting Zn are given in Figure 3 and Figure 4.



Main predictor is SOD;

if SOD≤6,120 Zn is 33,315
Main predictor is Ca
if Ca≤5026,830 Zn is 33,820
if Ca>5026,830 Zn is 32,810

if SOD>6,120 Zn is 37,707
Main predictor is Mg
if Mg≤2347,325 Zn is 39,176
Main predictor is N
if N≤1,945 Zn is 39,120
if N>1,945 Zn is 39,230

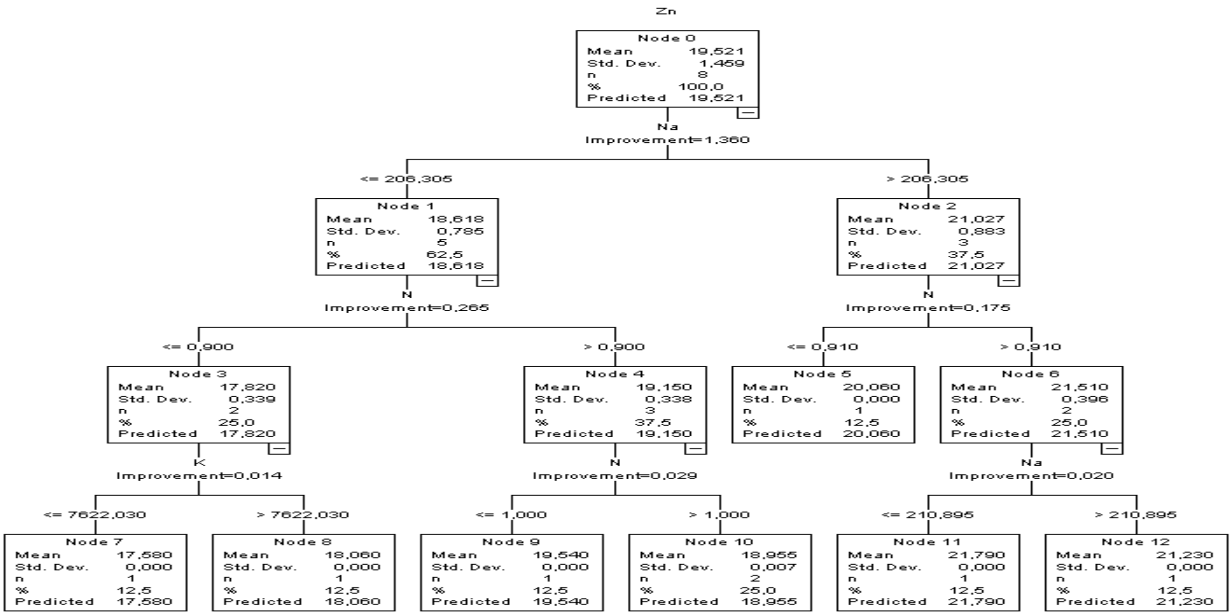
if Mg>2347,325 Zn is 36,972
Main predictor is Fe
if Fe≤149,685 Zn is 37,495
Main predictor is Na
if Na≤173,810 Zn is 37,250
if Na>173,810 Zn is 37,740

if Fe>149,685 Zn is 36,450
Main predictor is K
if K≤4236,495 Zn is 36,360
if K>4236,495 Zn is 36,540

R^2: [1- -[illegible]: [1- $\frac{1,59}{5,30}$]: 1-0,30: 0,70

Figure 3. Decision tree analysis to determine the factors affecting Zn on whole seed in wheat

Figure 3 exposed the effective components on Zn in whole seed. Main predictor was SOD, sub predictors were Ca, Mg, N, Fe and K. Na and N. Increase in SOD highly increased Zn amount. Second main determinants in lower and higher SOD levels were Ca and Mg, respectively. Zn increased with raising Ca in lower SOD level. Moreover, in higher SOD level, increasing Mg level caused decrease in Zn content. Main determinants in lower and higher Mg levels were N and Fe, respectively. In lower Mg level, raising N content made slightly increase in Zn. Rearing up Zn content occurred with raising Fe level in higher Mg level. In lower Fe level, increasing Na level increased in Zn content. In higher Fe level, Zn content increased with increasing K level. SOD, Ca, Mg, N, Fe, Na and K were determined as significant determinants in Zn activity.



Main predictor is Na;

if Na≤206,305 Zn is 18,610
- Main predictor is N
  - if N≤0,900 Zn is 17,820
    - Main predictor is K
      - if K≤7622,030 Zn is 17,580
      - if K>7622,030 Zn is 18,060
  - if N>0,900 Zn is 19,150
    - Main predictor is N
      - if N≤1,000 Zn is 19,540
      - if N>1,000 Zn is 19,855

if Na>206,305 Zn is 21,027
- Main predictor is N
  - if N≤0,910 Zn is 20,060
  - if N>0,910 Zn is 21,510
    - Main predictor is Na
      - if Na≤210,895 Zn is 21,790
      - if Na>210,895 Zn is 21,230

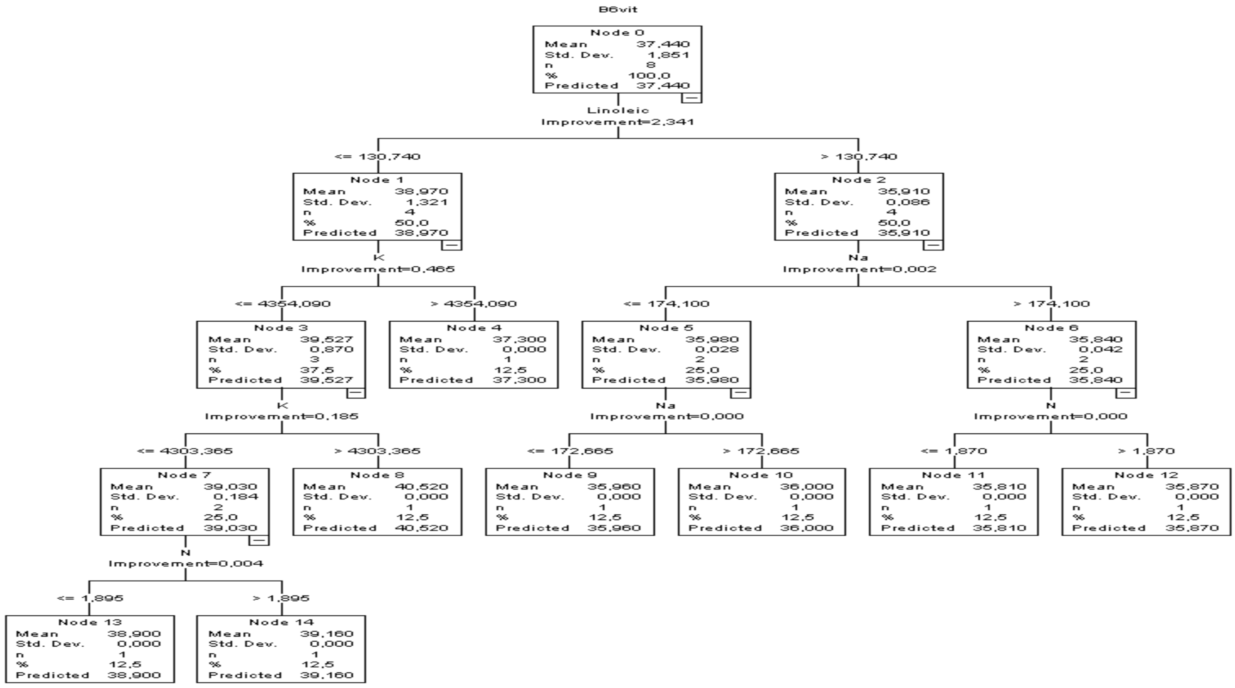
R^2: [1- [illegible]: [1- $\frac{0,66}{2,12}$]: 1-0,32: 0,68

Figure 4. Decision tree analysis performed to determine the factors affecting Zn in the lipids extracted from wheat embryo

Figure 4 assign the effective components on Zn on lipids. Main predictor and sub predictor were determined as Na and N, respectively. Increase in Na increased Zn amount. N was main predictor and N affects significantly increase Zn in lower and higher Na levels. In lower N level, K was predictor, and Zn raised with increasing K level. When N level was higher, increasing N content made slightly increase in Zn. Once Na was predictor in higher N, decrease was taken place in Zn, with increasing Na level. Na, N, K and Na were determined as important predictors. SOD, Ca, Mg, N, Fe, Na and K were concluded as significant components in Zn activity.

3. 5. B_6 vitamin

In order to meet and meet the body's basic needs, vitamin, mineral, protein, carbohydrate and mineral intakes are very important, and one of the important vitamins in meeting these needs is vitamin B_6 (pyridoxine). Vitamin B_6 supports many important functions such as metabolism of proteins, production of red blood cells, nervous system functions, immune system functions and skin health. Vitamin B_6 is found naturally in many foods, especially meat, fish, chicken, whole-grain bread and cereals, and vegetables such as potatoes, bananas, avocados, and kale. Vitamin B_6 has a regulatory function and plays a supporting role as a coenzyme and cofactor during the performance of many functions in the body. Vitamin B_6 has functions in many areas such as the hormonal system, nervous system, immune system and blood production. In order for the body to perform its daily functions, the need for macro and micronutrients must be fully met with a healthy and balanced diet. The daily need for vitamin B_6 is known to be 1.2-1.7 mg [23].



Main predictor is Linoleic;

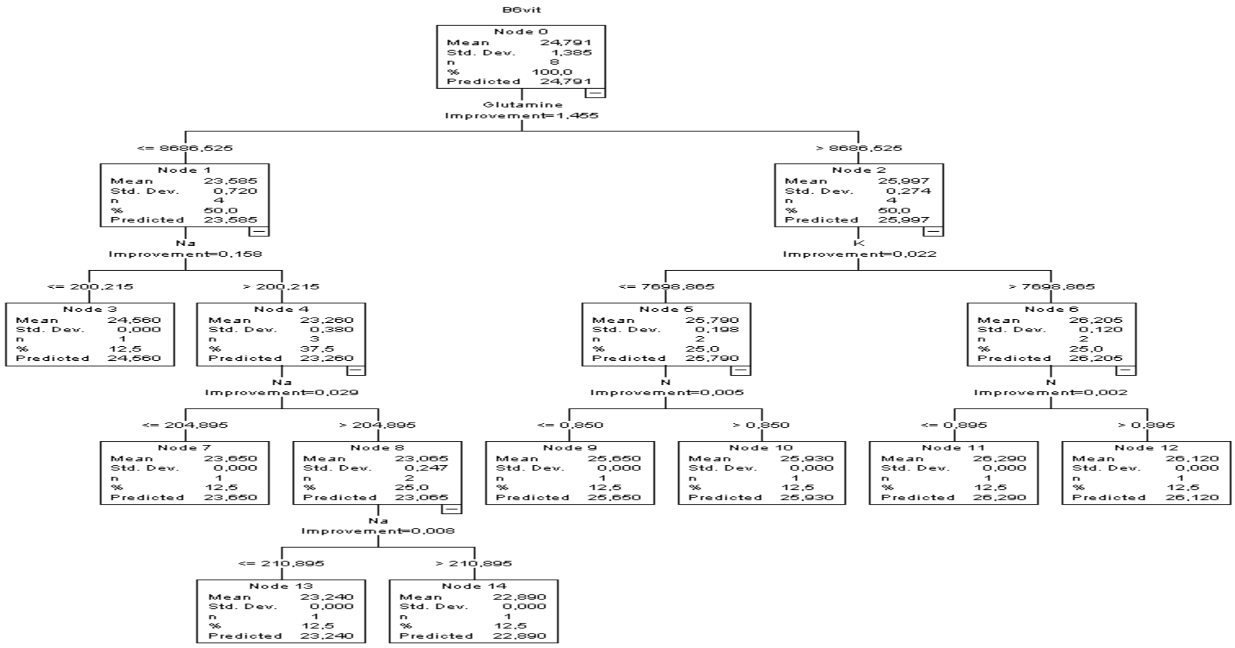
if Linoleic≤130,740 B_6 is 38,970
Main predictor is K
if K≤4364,090 B_6 is 39,527 if K>4364,090 B_6 is 37,300
Main predictor is K
if K≤4303,365 B_6 is 39,030 if K>4303,365 B_6 is 40,520
Main predictor is N
if N≤1,895 B_6 is 38,900
if K>1,895 B_6 is 39,160

if Linoleic>130,740 B_6 is 35,910
Main predictor is Na
if Na≤174,100 B_6 is 35,980 if Na>174,100 B_6 is 36,840
Main predictor is Na
if Na≤172,665 B_6 is 36,980
if Na>172,665 B_6 is 36,000
Main predictor is N
if N≤1,870 B_6 is 36,810
if N>1,870 B_6 is 36,870

R^2: [1- $\frac{\text{[illegible]}}{\text{[illegible]}}$: [1- $\frac{0,43}{3,43}$]: 1-0,26: 0,74

Figure 5. Decision tree analysis to determine the factors affecting B_6 on whole seed in wheat

Vitamin B_6 is an important cofactor in many enzymatic reactions in plants and plays an important role in the plant's tolerance or defence system against abiotic stresses. Additionally, high levels of vitamin B_6 in the plant lipids and the whole seed lead to an increase in the nutritional quality of the variety [23]. Decision tree analyses performed overall seed and extracted lipids in order to determine the factors affecting B_6 are given in Figure 5 and Figure 6. Main important components for B_6 in whole seed were given in Figure 5. Main predictor was linoleic, sub predictors were K and Na. Increase in linoleic caused decline in B_6, and K decreased B_6 level in lower linoleic level. In lower K level, main predictor seemed K, with raising it, B_6 level increased. In higher linoleic level, raise in Na and N levels could not create certain changes in B_6 level (Figure 5). Linoleic, N, Na and K were determined as significant determinants in B_6 activity.



Main predictor is Glutamine;

if Glutamine≤8686,525 B_6 is 23,585
Main predictor is Na
if Na≤200,215 B_6 is 24,560
if Na>200,215 B_6 is 23,260
Main predictor is Na
if Na≤204,895 B_6 is 23,650
if Na>204,895 B_6 is 23,065
Main predictor is Na
if Na≤210,895 B_6 is 23,240
if Na>210,895 B_6 is 22,890

if Glutamine>8686,525 B_6 is 25,997
Main predictor is K
if K≤7698,865 B_6 is 25,790
Main predictor is
if N≤0,850 B_6 is 25,650
if N>0,850 B_6 is 25,930
if Na>7698,865 B_6 is 26,205
Main predictor is N
if N≤0,895 B_6 is 26,290
if N>0,895 B_6 is 26,120

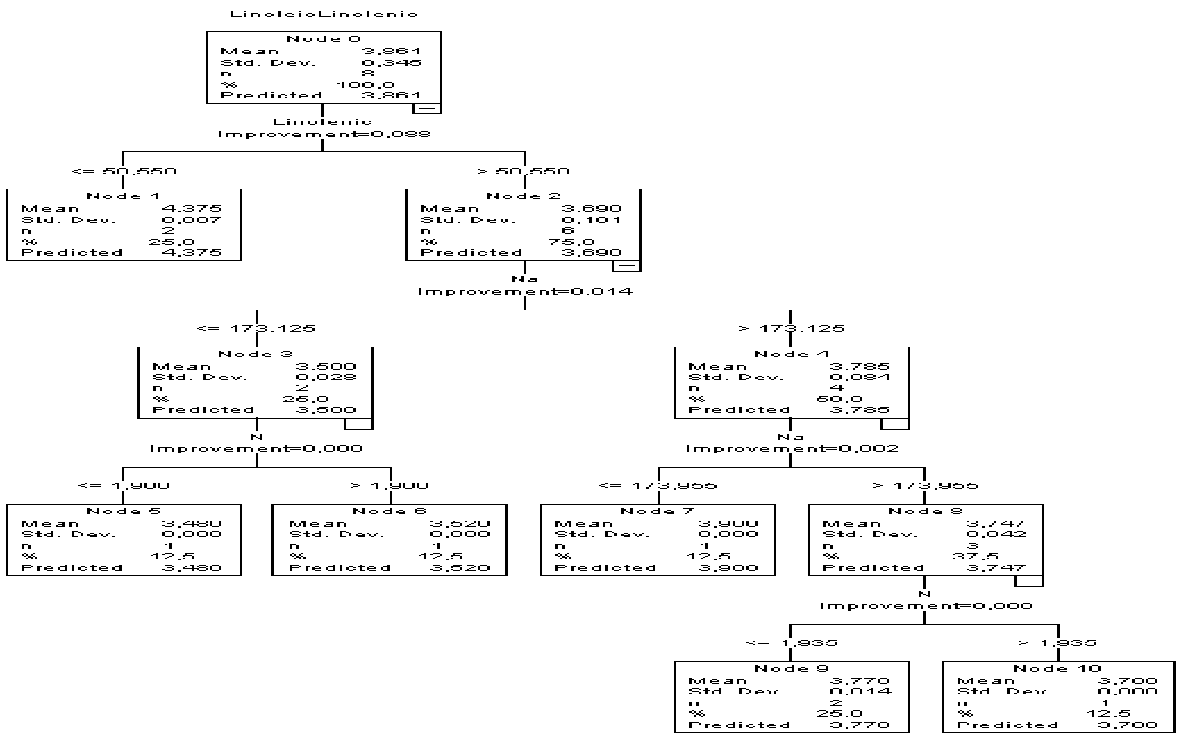
R^2: [1- [illegible]: [1- $\frac{0,49}{1,92}$]: 1-0,26: 0,74

Figure 6. Decision tree analysis performed to determine the factors affecting B_6 in the lipids extracted from wheat embryo

Significant components on B_6 in lipids extracted were given in Figure 6. Main predictor was glutamine, sub predictors were K and Na. Increase in glutamine increased in B_6 in lower glutamine level, raising Na lowered B_6. In higher glutamine level, B_6 level increased with raising K amount. Though increasing N increased B_6 in lower K level, B_6 declined with increasing N level in higher K level. As in whole seed, glutamine, N, Na and K seemed significant components in B_6 action. Significant components were found in whole seed and lipids as linoleic, glutamine, N, Na and K for B_6.

3. 6. Rate of linoleic acid/linolenic acid

Essential fatty acids are fatty acids that cannot be synthesized in the body and that humans and animals must obtain from outside in order to survive. The most important fatty acids among essential fatty acids are linoleic acid and linolenic acid. Linoleic acid is a polyunsaturated fatty acid, a colourless or white lipids that is virtually insoluble in water but soluble in many organic solvents. It is one of the three essential fatty acids [24] that humans must obtain through diet. Since it is an essential fatty acid, linoleic acid consumption is vital for a healthy life. Another essential fatty acid is linolenic acid. Deficiency of both fatty acids causes serious problems, especially in brain and eye development. It also causes depression and behavioural disorders [24]. On the other hand, these two fatty acids have potential effects in the prevention and treatment of coronary heart diseases, hypertension, type 2 diabetes, ulcerative colitis, rheumatoid arthritis, depression, various cancers and chronic obstructive pulmonary diseases, with their properties such as anti-inflammatory, blood flow regulator and heart rhythm regulator. [24]. Linoleic acid and linolenic acid are large molecules and are formed by the combination of small molecules through dehydration reactions. Since there is a lot of hydrogen in their structure, because of their destruction by aerobic respiration in plants, abundant energy is produced and abundant metabolic water is formed. It participates in the structure of the cell membrane. It participates in the structure of some vitamins such as vitamin D. They are easy to destroy. Although it is richly found in many lipids such as olive lipids, cottonseed lipids, soybean lipids, corn lipids, hazelnut lipids, etc., it is present in a certain amount in wheat grain and lipids. It supports the plant defence mechanism against free radicals formed because of oxidative stress caused by free radicals formed by normal metabolism or environmental factors. It is involved in the cell membrane in cold resistance and ion uptake [24]. The World Health Organization states that a linolenic acid/linoleic acid ratio between 5/1 and 10/1 is necessary for a healthy diet. It is reported that these ratios are the desired ratios in foods in an ideal diet. Therefore, varieties high in this ratio have high nutritional quality [24]. The decision tree analysis performed to determine the factors affecting the Rate of Linolenic acid is given in Figure 7 and Figure 8.

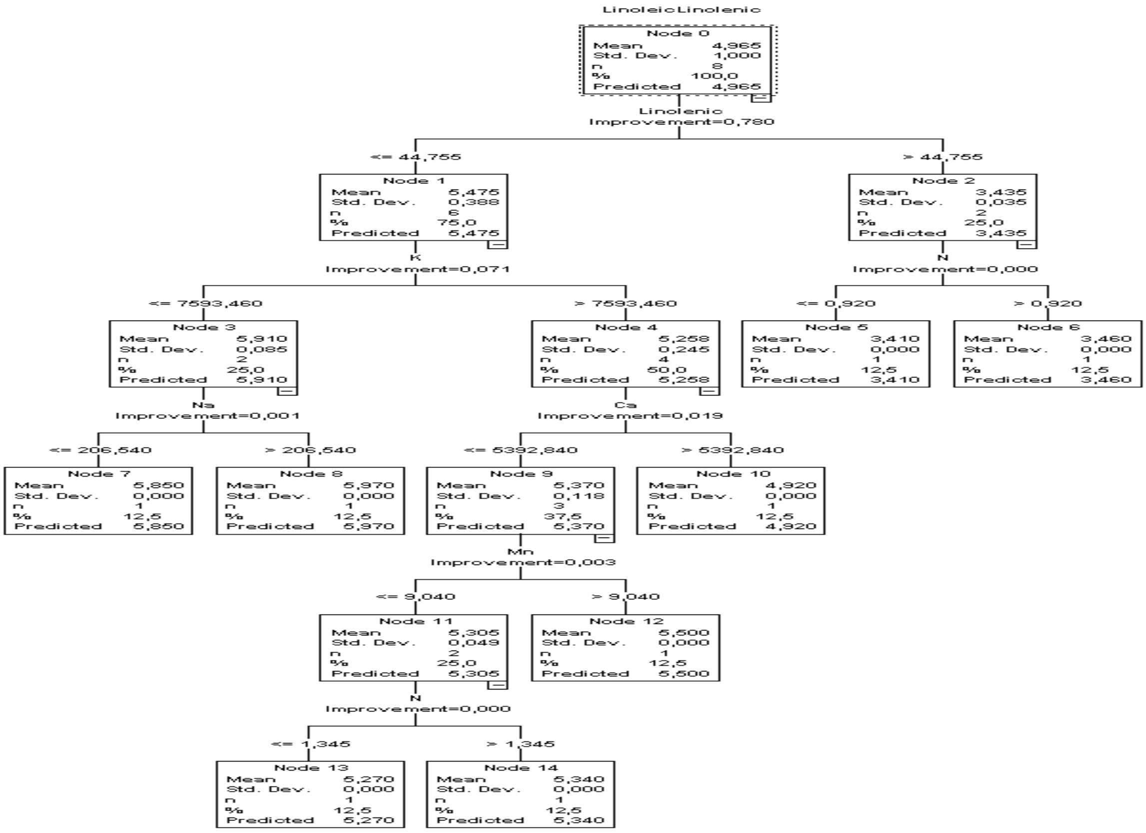


Main predictor is Linolenic;
if Linolenic≤50,550 Linoleic/Linolenic is 4,375 if Linolenic>50,550 Linoleic/Linolenic is 3,690
Main predictor is Na
if Na≤173,125 Linoleic/Linolenic 3,500 if Na>173,125 Linoleic/Linolenic 3,900
Main predictor is N
if N≤1,900 Linoleic/Linolenic 3,480
if N>1,900 Linoleic/Linolenic 3,520
Main predictor is Na
if N≤173,955 Linoleic/Linolenic 3,480 if N>173,955 Linoleic/Linolenic 3,747
Main predictor is N
if N≤1,935 Linoleic/Linolenic 3,770
if N>1,935 Linoleic/Linolenic 3,700

R^2: [1- $\frac{\text{Risk Estimation}}{Az}$: [1- $\frac{0,66}{0,12}$]: 1-0,34: 0,66

Figure 7. Decision tree analysis to determine the factors affecting linoleic/linolenic on whole seed in wheat

Important effectual components for linoleic/linolenic in whole seed were given in Figure 7. Main predictor was linolenic, increase in linolenic caused decline in linoleic/linolenic rate. In higher linolenic level, sub predictor was Na, stepping up Na level increased linoleic/linolenic rate. In lower Na level, N was sub predictor and increment of N increased linoleic/linolenic rate. In higher Na level, Na and N were sub predictors. Once augmenting Na and N levels made decrease and increase in linoleic/linolenic rate, respectively (Figure 7). Significant components having effect on linoleic/linolenic rate were linolenic, N, Na.



Main predictor is Linolenic;

if Linolenic≤44,755 Linoleic/Linolenic is 5,475
Main predictor is K
if K≤7693,460 Linoleic/Linolenic is 5,910
Main predictor is Na
if Na≤206,640 Linoleic/Linolenic is 5,850
if Na>206,640 Linoleic/Linolenic is 5,970
if K>7693,460 Linoleic/Linolenic is 5,258
Main predictor is Ca
if Ca≤5392,840 Linoleic/Linolenic is 5,370
Main predictor is Mn
if Mn≤9,040 Linoleic/Linolenic is 5,305
Main predictor is N
if N≤1,345 Linoleic/Linolenic is 5,270
if N>1,345 Linoleic/Linolenic is 5,340
if Mn>9,040 Linoleic/Linolenic is 5,500
if Ca>5392,840 Linoleic/Linolenic is 4,920
if Linolenic >44,755 Linoleic/Linolenic is 3,435
Main predictor is N
if N≤0,920 Linoleic/Linolenic is 3,410
if N>0,920 Linoleic/Linolenic is 3,460

R^2: [1- $\frac{\text{[illegible]}}{\text{[illegible]}}$: [1- $\frac{0,29}{1,00}$]: 1-0,29: 0,71

Figure 8. Decision tree analysis performed to determine the factors affecting linoleic/linolenic in the lipids extracted from wheat embryo

Only in Figure 8 was linolenic main predictor, rise in linolenic declined linoleic/linolenic rate. In higher linolenic level, sub predictor was N, increasing Na level increased linoleic/linolenic rate. In lower linolenic level, K was sub predictor and increment of K increased linoleic/linolenic rate. In lower K level, Na as a sub predictor, increased linoleic/linolenic rate. In higher K level, Ca was a sub predictor, decreased linoleic/linolenic rate. In lower Ca level, Mn was sub predictor and increasing Mn level increased linoleic/linolenic rate. In lower Mn level, N was sub predictor and made increase in linoleic/linolenic rate by increasing it. (Figure 8). Significant components were determined as linolenic, K, N, Na and Mn. Significant components in whole seed and lipids were found as linolenic, K, N, Na and Mn.

4. Conclusions and discussion

Wheat has a certain potential in terms of the components examined, but it is not sufficient in terms of nutrition alone. Especially the nutritional value of wheat, which we mentioned above, is far from meeting the daily needs of human beings. The solution to this need is through balanced nutrition. Instead of a one-way diet, it is necessary to have a balanced diet with plant foods such as vegetables and fruits and animal foods such as meat and chicken. In wheat embryo, especially in the embryo, lipids is used both as a building block and as an energy source in the structure of the cell membrane, in metabolic events that start from embryonisation to full maturity. As shown in this article, it contains approximately half of the minerals, amino acids, enzymes, sugars and other compounds present in the lipids. On the other hand, this lipids amount and its content composition are important for bread quality. Therefore, consuming whole wheat flour containing embryo and bran provides a better quality nutrition. This rich content of wheat lipids makes it a valuable substance for the cosmetic industry. The results showed that **Tosunbey-G1, Alpu 01-G2, ES26-G3** and **Nacibey-G5** had the highest nutritional values and better activity. The ratio of minerals, amino acids, fatty acids, enzymes and vitamins in lipids to the whole seed was determined as 53%, 63% and 68%, respectively. Moreover, except for Ca and linoleic acid/linolenic acid ratio, the differences between whole seed and lipids in genotypes for the other components were found to be significant at the 1% level. The differences between Ca and linoleic acid/linolenic acid ratio were found to be insignificant and significant at the 5% level, respectively. In wheat, the ratio of lipids components to the whole seed is approximately one third. There are certain substances in wheat; lysine, Zn, B_6 vitamin and the rate of linoleic acid/linolenic are known as essential components, making nutritional quality better. The factors affecting the activity of these components were estimated by decision tree analysis. Mn, tryptophan, Na, N and Ca were found as effective components in the shaping and activity of lysine. SOD, Ca, Mg, N, Fe, Na and K were concluded as significant components in Zn activity. Significant components were found in whole seed and lipids as linoleic, glutamine, N, Na and K for B_6 vitamin. In linoleic/linolenic rate, linolenic, N, Na were important components. Studies that are more detailed are needed to better understand this issue.

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