EFFECT OF HUMIC ACID DOSE ON BARLEY NUTRITIONAL QUALITY

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Abstract

Barley is one of the most cultivated field crops in the world after wheat, corn and rice. It is an important plant used in animal feeding. Barley production areas have also been affected by the decreasing agricultural areas in recent years. The most traditional solution to reach maximum yield and quality values from a unit area is plant nutrition with chemical or organic fertilizers. The use of organic fertilizers is becoming widespread due to the environmental threat posed by chemical fertilizers. In this regard, organic fertilizers containing humic acid, which are known to have positive effects on plant yield and quality, attract attention. The research was carried out in the 2022-2023 barley production season in order to determine the effective doses of humic acid fertilizers on barley nutrition value. In the trial established according to the split-split block trial design, 3 different varieties and 5 different humic acid doses were applied with 3 replications. While the application of 200 ml per decare was found to be important in terms of protein and oil content, no significant effect was determined on the starch, fiber, hardness, moisture, fatty acid values of the application doses.

Key words: Nutritional value, Humic acid, Barley

INTRODUCTION

Barley; It has an important place among the world's grain resources as animal feed, malt products and human food. A large part of the barley produced in the world and in our country is used as animal feed. Since barley is a healthy grain that can be used for various purposes and as an additive in many foods, it is considered the grain of the future. Barley bread has been the food of people in some parts of Europe for centuries during the time of the ancient Greeks and Romans, and the fact that barley dough is not leavened, that is, it does not rise when baked, causes barley bread to be more delicious. hard. The fact that wheat bread is fluffier and lighter than barley bread has caused barley to be replaced by wheat as a flour grain over time. (Mızrak, 2000). In developed countries, the use of barley as human food is less than 5% of total production. However, in recent years, barley; It has attracted attention in food production due to its protein, dietary fiber, non-starch polysaccharides, cellulose and arabinoxylan content and its rich starch content. Its consumption as food is increasing day by day. Barley is recognized for its high fiber content, particularly β-glucan, (Ain et al., 2018). The presence of β-glucan is associated with various health benefits, including cholesterol reduction and improved glycemic control (Lukinac & Jukić, 2022).

Barley (Hordeum vulgare L.) is a cereal grain with significant nutritional value, characterized by various components such as starch, protein, fiber, moisture, fatty acids and oil content. Barley is affected by factors such as variety, processing methods and environmental conditions. In addition, plant nutrition methods also cause changes in the components that constitute the nutritional values of barley. The aim of this study is to determine the effect of humic acid used as an organic fertilizer on the nutritional value of barley.

MATERIALS AND METHODS

The study was carried out in the 2022-2023 barley growing season in the Ege University application field.

The trial was established according to the split-split plots trial design with 3 varieties and 5 humic acid doses (control, 100 ml/da, 150 ml/da, 200 ml/da, 250 ml/da) with 3 replications.

NPK fertilizer was applied with 8 kg nitrogen per decare together with planting. Humic acid was applied with a hand pulverizer at 15-day intervals from the stemming period of the plants.

Harvest was done by selecting 10 plants from each plot and separated into grains. Protein, fiber, oil, fatty oil, starch, moisture values were determined using the NIR spectrophotometer device using barley grains. The results were analyzed with the JMP statistics program.

RESULTS AND DISCUSSIONS

According to the variance analysis table, protein ratio was found to be significant at the 0.01 significance level, while fat content was found to be significant at the 0.05 significance level. There is no statistical significance among the other features. Table 1.

Table 1. Variance Analysis

Variance source	***Protein***	***Starch***	***Fatty Acid***	***Fat***	***Fiber***
Dose	3,06**	5,97	2,47	0,06*	0,16
Variety	1,26	8,61	1,72	0,11	0,32
*Dose*Variety*	0,59	35,50	3,59	0,03	0,28
Replication	0,23	1,44	1,32	0,00	0,15
Error	0,50	24,22	4,98	0,04	0,38

Table 2. Average values of varieties according to doses

	PROTEIN	**STARCH**	**FATTY ACID**	**FAT**	**FIBER**
1,ALHİSAR	9,35**cd**	69,57	27,53	2,65**cd**	13,50
1,ATABEYİ	9,86**bcd**	73,44	28,09	2,69**bcd**	13,41
1,AZİZBEY	8,99**d**	69,39	28,94	2,58**d**	13,50
2,ALHİSAR	9,74**bcd**	76,68	28,26	2,72**bcd**	13,88
2,ATABEYİ	10,08**bcd**	72,90	28,24	2,73**bcd**	13,64
2,AZİZBEY	10,37**bc**	68,85	28,49	2,98**abc**	13,34
3,ALHİSAR	10,12**bcd**	73,26	26,32	2,91**abcd**	13,16
3,ATABEYİ	10,34**bc**	70,20	27,71	2,81**abcd**	13,55
3,AZİZBEY	10,47**bc**	75,78	29,90	2,81**abcd**	13,92
4,ALHİSAR	10,43**bc**	69,12	28,48	2,82**abcd**	13,76
4,ATABEYİ	10,50**bc**	72,36	29,40	2,90**abcd**	13,34
4,AZİZBEY	11,94**a**	72,90	26,76	3,09**a**	12,98
5,ALHİSAR	10,11**bcd**	69,12	28,91	2,74**bcd**	14,14
5,ATABEYİ	10,71**b**	71,64	29,28	2,90**abcd**	13,80
5,AZİZBEY	10,86**ab**	77,13	29,15	3,01**ab**	13,67

Studies show that humic acid increases the nutrient uptake of the barley plant and this increases the protein content. In this study, protein ratios were found between 11.94 and 8.99 (Table 2.) and humic acid showed the highest performance at 200 ml per decare (Figure 1.).

The protein content in barley varies between 8.7% and 16% depending on the variety and environmental conditions (Ekaette & Saldaña, 2020). Our experiment result is consistent with the 10.31-12.05% reported by Koca et al. (2015) in a two-year study conducted to determine the nutritional values of barley grain for feed ration in Aydın conditions, 9.4-11.3 reported by Öztürk et al. (2007), and 9.4-11.3 reported by Budaklı et al. (2005) reported 9.34-11.16 values, close to 10.9-13.1 values reported by Sirat and Sezer (2009). It was lower than the protein ratio values of 11.7-15.1 reported by (İmamoğlu and Yılmaz 2012), 12.27-16.32% reported by Kızılgeçi et al. (2016), and 14.0-17.2% reported by (Oral et al. 2007).

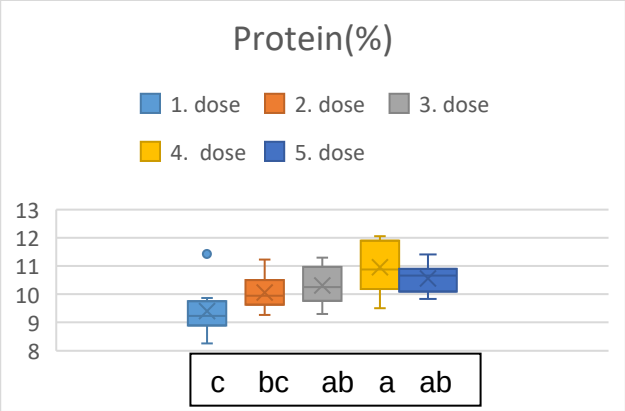

Figure 1. Mean values of protein and LDS groups

The protein content in barley ranges from 8.7% to 16% depending on the variety and environmental conditions (Ekaette & Saldaña, 2020). A study highlighted that the protein content is negatively correlated with starch content, suggesting that as protein levels increase, starch levels tend to decrease (Fox et al., 2019). This relationship is particularly important in malting barley, where a specific protein range (9-12%) is desired for optimal brewing quality (Fox et al., 2019). Additionally, the protein composition includes essential amino acids, making barley a valuable source of nutrition (Lukinac & Jukić, 2022)

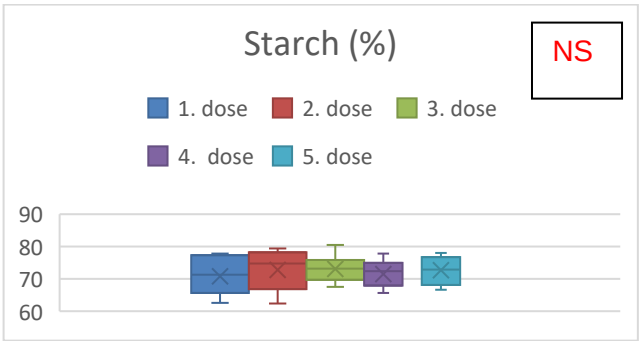

Figure 2. Mean values of starch

According to Table 2, starch values were found between 69 and 77. Starch constitutes a substantial portion of barley grain, typically accounting for approximately 62-77% of the total dry weight (Yu et al., 2020; Sorour et al., 2021). The starch in barley is primarily composed of amylopectin and amylose, with amylose content varying significantly among different barley cultivars. For instance, standard barley contains about 20-30% amylose, while waxy barley has less than 5% (Cian, 2023).

There is an inverse relationship between protein and starch ratio in the grain. This situation is due to the filling of starch and protein substances in the grain at different maturity periods. Physiological maturity periods (milk and yellow maturity) are largely affected by environmental conditions. Generally, in periods when the yellowing period lasts longer, starch accumulation in the grain increases and causes an increase in grain weight, and with this increase, a proportional decrease in protein occurs (Nemati et al., 2009). It is observed that there is higher rainfall compared to long-term averages during the growing period from January to June until May (Table 3.2). The amount of rainfall is high in the first stages of plant growth and low in the later stages, which reduces the protein content of the grain (Aalami et al. 2007). Higher rainfall compared to long-term averages during April, which is the milking stage, has a negative effect on protein accumulation in the milking stage. It is thought that the fact that the yellowing stage lasts longer than the milking stage causes lower protein rates and higher starch rates. In addition, it is known that in barley cultivation, when there is sufficient N, plant protein content decreases (Akmaz, V. 2022) and increases protein rate with increasing doses (Janković, S., 2009).

Another reason why protein levels are lower than some of the reported levels may be due to the lack of spring fertilization.

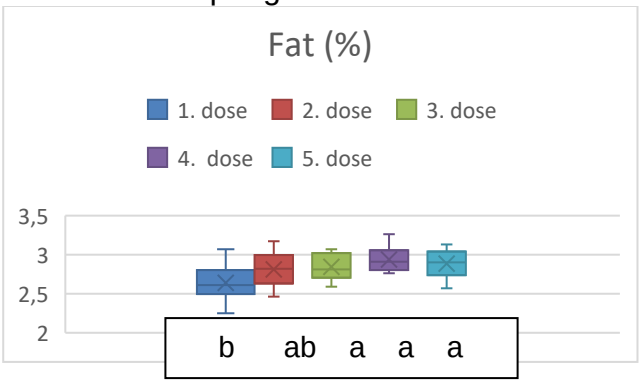

Figure 3. Mean values of fat and LSD groups

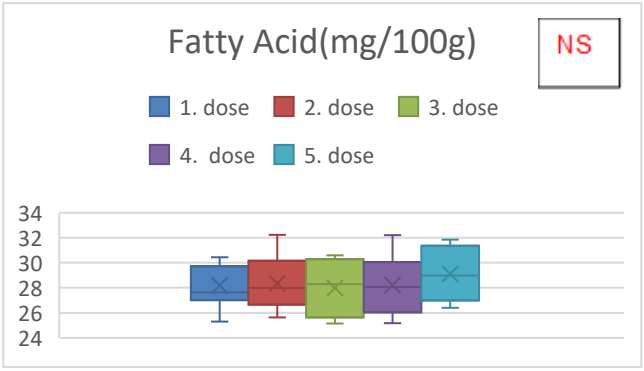

Figure 4. Mean values of fatty acid

The oil content varied between 2.58 and 3.09. The 3rd, 4th and 5th dose applications of 150 ml, 200 ml and 250 ml per decare were in a statistically different group from the others at the 0.05 significance level in the 1st and 2nd dose applications (Figure 3).

Barley contains a relatively low oil content, generally around 2-3% (Uyanık, 2023). However, certain barley varieties, particularly those used in brewing, can exhibit higher oil levels, which are beneficial for extracting bioactive compounds (Badea et al., 2018). The fatty acid profile of barley is also noteworthy, with a predominance of unsaturated fatty acids, which are considered healthier than saturated fats. The oil content can vary significantly among different barley genotypes, indicating the potential for breeding programs aimed at enhancing oil yield (Badea et al., 2018).

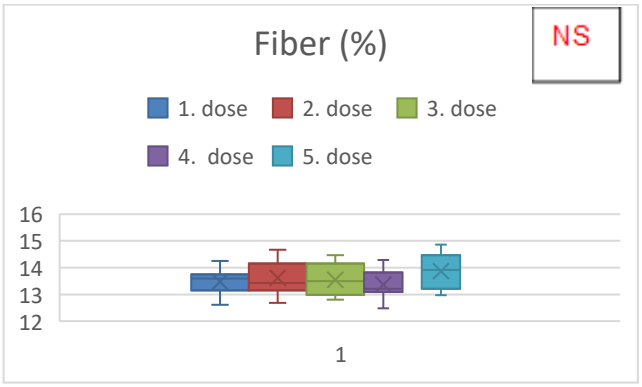

Figure 5. Mean values of fiber

Fiber values vary between 12.1 and 13.8(Figure 5.). Ain et al., 2018 reported that it varies between 3.65% and 23.8% depending on the variety and processing methods, while Åman and Newman (1986) reported that it varies between 20 and 5%.

Studies have shown that the fiber content can be influenced by the barley's growing conditions and the specific cultivar used, with some highland barley varieties exhibiting superior fiber profiles (Bin et al., 2022). The processing of barley, such as milling, can also affect fiber retention, impacting its nutritional benefits (Li et al., 2022).

CONCLUSIONS

As a result, the 4th dose application of 200 ml/da caused a significant increase in protein content and oil content.

No significant effect of humic acid applications was found among the varieties.

The nutritional profile of barley is important to optimize its applications in the food and feed industries. Further studies are needed to increase the value of barley as a functional food ingredient with the use of organic fertilizers.

REFERENCES

Ain et al. "Modification of barley dietary fiber through chemical treatments in combination with thermal treatment to improve its bioactive properties" International Journal of Food Properties (2018) doi:10.1080/10942912.2018.152845

Akmaz, V. (2022). Spektral yansıma ve dijital verilere dayalı özelliklerin arpa

(Hordeum vulgare L.) genotiplerinde verim ve kalite ile ilişkilerinin belirlenmesi (Doctoral dissertation, Yüksek Lisans Tezi, Dicle Üniversitesi, Fen Bilimleri Enstitüsü, Tarla Bitkileri Ana Bilim Dalı, Diyarbakır, 82s).

Åman, P., & Newman, C. W. (1986). Chemical composition of some different types of barley grown in Montana, U.S.A. Journal of Cereal Science, 4(2), 133–141.

Budaklı, E, et al. 2005. Bazı İki Sıralı Arpa (Hordeum vulgare conv. Distichon) Çeşitlerinde Farklı Azot Dozlarının Verim, Verim Unsurları ve Kalite Üzerine Etkileri. Uludağ Üniversitesi Ziraat Fakültesi Dergisi 19 (2): 1-11.

Cian "Barley and Malt as Base Ingredients for the Production of New Bio-Functional Foods" Recent progress in nutrition (2023) doi:10.21926/rpn.2303018 https://doi.org/10.1002/cche.10093

Ekaette and Saldaña "The Effect of Rutin on Starch Hydrogels/Aerogels Made from Electrolyzed Barley Flour" Starch - stärke (2020) doi:10.1002/star.202000099

Fox et al. "Effect of varying starch properties and mashing conditions on wort sugar profiles" Journal of the Institute of Brewing (2019) doi:10.1002/jib.585

Imamoğlu A., Yilmaz N, 2012, Bursa Ekolojik Koşullarinda Bazi Arpa (Hordeum Vulgare L.) Genotiplerinin Verim Ve Bazi Kalite Özelliklerinin Belirlenmesi Anadolu, J. Of Aari 22 (2), 13 - 36 Mfal

Janković, S. et al. (2011). Effects of nitrogen fertilization on yield and grain quality in malting barley. African Journal of Biotechnology, 10(84), 19534-19541.

Kızılgeçi, F., et al. (2016). Bazı arpa genotiplerinin Diyarbakır ve Mardin koĢullarında verim ve kalite parametrelerinin incelenmesi. Iğdır Üni. Fen Bilimleri Enst. Der. / Iğdır Univ. J. Inst. Sci. & Tech. 6(3): 161-169.

Koca, Y. O., Erekul, O., Sabancı, S., Zeybek, A., Yiğit, A. (2015). Akdeniz kuşağında yetiiştirilen arpa (Hordeum vulgare L.) çeşitlerinde verim unsurları ve tane kalite özelliklerinin belirlenmesi. Adnan Menderes Üniversitesi Ziraat Fakültesi Dergisi, 12 (1), 9-15.

Badea, A., et. al. (2018). Tocols and oil content in whole grain, brewer's spent grain, and pearling fractions of malting, feed, and food barley genotypes. Cereal Chemistry, 95(6), 779-789.

Bin et al. (2022) "Evaluation of Nutritional Components, Phenolic Composition, and Antioxidant Capacity of Highland Barley with Different Grain Colors on the Qinghai Tibet Plateau" Foods

Li et al. "Beneficial Effects of Partly Milled Highland Barley on the Prevention of High-Fat Diet-Induced Glycometabolic Disorder and the Modulation of Gut Microbiota in Mice" Nutrients (2022) doi:10.3390/nu14040762

Lukinac and Jukić "Barley in the Production of Cereal-Based Products" Plants (2022) doi:10.3390/plants11243519

Mızrak, G., 2000, Buğday ve arpa taban fiyatının belirlenmesi, Türk Ziraat Mühendisleri Birliği ve Vakfı, Nadir Kitap Yayınları, June

Nematı, A., et al. (2009). Investigation of correlation between traits and path analysis of corn (Zea mays L.) grain yield at the climate of Ardabil region (Northwest Iran). Notulae Botanicae Horti Agrobotanici Cluj 37(1): 194-198.

Oral E, Kendal E, Doğan Y. (2007), Bazı Yazlık Arpa (Hordeum vulgare L.) Genotiplerinin Verim ve Kalite Yönünden Değerlendirilmesi, Iğdır Univ. J. Inst. Sci. & Tech. 7(1): 31-38

Öztürk. İ., R. Avcı, T. Kahraman. 2007. Trakya Bölgesi'nde yetiştirilen bazı arpa (Hordeum vulgare L) çeşitlerinin verim ve verim unsurları ile bazı kalite özelliklerinin belirlenmesi. Trakya Üniv. Zir. Fak. dergisi, 21 (1): 59-68.

Sirat, A. ve İ. Sezer. 2009. Bafra ovası koşullarına uygun arpa (Hordeum vulgare L.)çeşitlerinin belirlenmesi.

Anadolu Tarım Bilim. Dergisi 24(3):167-173.

Sorour et al. "Impact of Soaking and Germination Processes on Starch and Non-Starch Polysaccharides in some Egyptian Barley Cultivars" Journal of Food and Dairy Sciences (2021) doi:10.21608/jfds.2021.78195.1021

Uyanik "Chemical Composition in Barley (Hordeum vulgare L.) as Affected by Hectoliter Weight" Journal of Agricultural Faculty of Gaziosmanpasa University (2023) doi:10.55507/gopzfd.1251826

Yu et al. "Malt protein inhibition of β-amylase alters starch molecular structure during barley mashing" Food hydrocolloids (2020) doi:10.1016/j.foodhyd.2019.105423.