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NIR Spectroscopy Application for Quality Control of Grain Seeds Produced in Albania

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Abstract

Wheat and its processed products have been among the main staple foods of Europeans, including Albanians. Its nutritional importance stems from its role as a crucial source of microelements and its versatility in making many processed products, including bread, pasta, and pastries. Global marketplaces are concentrating on their quality indicators for safety and security. The study utilized near-infrared spectroscopy to assess the quality of domestically grown wheat by analyzing physicochemical characteristics, including protein, gluten, starch, moisture, and sedimentation index. This study applied NIRS in tandem with machine learning as a sustainable tool for processing and quality assessment of cereals.

Seventy-five samples were gathered from various areas throughout the 2022 harvesting season, either straight from the field or from silos. The protein content varied from 9.6–15.0%, with a mean of 12.7%. The gluten concentration ranged from 19.4% to 37.5%, with a mean of 27.5%. The starch content ranged from 66.3–71.5%, with a mean value of 68.9%. The sedimentation index ranged from 21.1 to 57.8 cm³, with an average of 37.6 cm³. The moisture levels ranged from 9.8% to 12.5%, indicating that all wheat samples remained within the maximum limit of 14.5% stipulated by national and European Union food regulations. The crop quality indicators generated in Albania met the quality criteria established by the EU and state food legislation.

Keywords: Near-Infrared Spectroscopy, Wheat, Protein, Gluten, Machine-Learning, Albania

Introduction

Cereals are the primary type of seed food used by humans for millennia. They are considered staple foods in various geographical regions, including rice, wheat, and maize. The *Triticum* genus includes wheat, a member of the *Poaceae* family. Additionally, this family encompasses different cereals, including corn, barley, rice, and rye [1]. The Fertile Crescent was where wheat was first cultivated in ancient times, extending to Europe and Asia [2]. *Triticum durum* and *T. aestivum* are the two wheat species, with the latter being commonly referred to as soft wheat, while *T. durum* is sometimes known as durum wheat. Soft wheat and its refined derivatives are indispensable in human nutrition. It is cultivated except in tropical climate regions [3]. Grain seeds are typically ground, and four is the commodity fraction used as food, but alternative consumption practices are also present [4].

Rice, wheat, and maize, known as the three principal cereal grains, serve as staple foods and primary sources of carbohydrates in our daily diet. While consumption may vary across regions, wheat grain is the most important commodity for Europeans and the global population [3,5].

Wheat seed comprises bran, endosperm, and germ, each part having distinct chemical compositions. The seed is composed of carbohydrates, proteins, and a small amount of lipids. The endosperm is composed of significant amounts of proteins, carbohydrates, and iron; the germ provides vitamins, trace minerals, and unsaturated and polyunsaturated fats. Usually, bran is separated before consumption, even though it is rich in dietary fiber [6,7].

Wheat stands out among cereals for its ability to produce bread and dough products, thanks to its gluten protein. Starch is the primary constituent of wheat flour, with proteins as the secondary component, including the gluten-forming gliadins and glutenin. The fat content is minimal in wheat seeds, regardless of species. It substantially contributes to our diet's energy, fiber, vitamins, and minerals. Its distinct characteristics make wheat stand out among other cereal grains. The proteins provide a cohesive texture to dough with the ability to stretch and bounce back, enabling the gas bubble formation and preservation, a mixture of air and carbon dioxide, during the bread-baking process [3,6].

Agriculture, Albania's paramount sector, is not just a statistic but a vital part of the nation's economy and livelihood. It constitutes around 58% of employment and 21% of the nation's GDP [8]. Although just 24% of the nation's overall area, Arable land is a crucial resource, with 43% situated in lowland regions with a comparatively high productive potential. Approximately 49% of the agricultural land is dedicated to cultivating feed crops [9].

Albanian agriculture's primary focus continues to be grain production, a tradition that is now evolving. The composition has shifted towards animal feed rather than human consumption. This shift reflects the changing needs and priorities in the agricultural sector. Livestock, now a significant part of total agricultural output, accounts for almost 50 percent. Crop and fruit production constitute 44% and 11%, respectively, although animal production represents over 50% of overall agricultural output [10].

Three agroecological regions are identified based on soil, climatic, geographical, and socio-economic characteristics: the Lowland region (0-200 m, above sea level, asl), a typical lowlands Mediterranean climate region; the Hill-land region (400–1000 m. asl) cultivates various crops and fruit trees; and the Mountainous region (1000–2700 m. asl) Wheat, barley, rye, and several other fruits are cultivated here [9].

In 2021, global wheat output amounted to over 900 million tons, produced on approximately 244 million hectares [11]. Within the European Union, about 50% of cultivated land dedicated to grain production is used for wheat. Albania predominantly cultivates maize and wheat as its primary grain crops, as seen in Table 1. Their cultivation is widespread nationwide in Fieri, Elbasan, Korça, and Tirana. The country's 2021 grain output shows that maize and wheat are the predominant crops, with wheat yielding a total of 225 thousand tons. The aggregate grain yield amounts to 691,353 tons of wheat, 225,171 tons of maize, 414,271 tons of barley, 15,310 tons of oats, and 33,309 tons of oats [12].

No.	District	Cereals	Wheat	Maize	Barley	Oats
1	Berati	32953	11636	17190	223	3904
2	Dibra	47266	7588	38516	302	227
3	Durrësi	41333	10404	29101	36	1792
4	Elbasani	98249	35297	57142	198	5341
5	Fieri	168386	62886	88517	4939	12044
6	Gjirokastër	16979	6327	8130	-	2522
7	Korça	85094	45950	26783	7983	2762
8	Kukësi	14586	2010	11271	-	547
9	Lezha	33138	11131	22007	-	-
10	Shkodër	52793	5105	47688	-	-
11	Tirana	46434	17558	25943	1409	1508
12	Vlora	54144	9280	41982	220	2662
	Total	691353	225171	414271	15310	33309

Table 1: Cereal Production in Albania During the Harvesting Year 2021 (Tons)

Source: [12].

The expanding global population has intensified pressure on cereal markets, necessitating meticulous quality control throughout the cereal commodity supply chain. Concerns regarding the safety and quality of wheat flour are prevalent among the general public due to its direct association with the attributes of products derived from flour and human health [1].

NIR (near-infrared spectroscopy) is a technique utilized to evaluate various characteristics of the quantity and quality of agricultural commodities [13]. The widespread application and worldwide recognition of moisture and protein content are attributable to their substantial economic importance. The methodology's accuracy is associated with the near-infrared (NIR) model. Additionally, macroconstituents such as starch and fat, as well as essential micronutrients, including amino acids, dietary fibers, and amylose, are routinely analyzed by NIR spectroscopy. Furthermore, it is employed during processing to ensure quality control by evaluating the moisture during milling or dough development. In addition, NIR is

used to grade and categorize substances based on characteristics such as vitreousness, color class, and insect presence. Finally, mycotoxins, contaminants, and ergot bodies in food are identified through their application [14,15].

In contrast to conventional analytical methods, NIRS offers several benefits, including reduced costs and shorter assessment times. This technique operates without prior sample preparation or chemical use, which confers notable benefits on an industrial scale regarding quality control and process monitoring [13]. NIR spectroscopy uses the 900–1700 nm spectral range to provide consistent, reliable information on food quality [16,17]. Its temporal range spans from the visible to the mid-infrared [18]. Complex structural information related to the chemical bond vibrations C-H, O-H, and N-H is obtained from the near-infrared region. These chemical groups are fundamental to organic molecules, such as sugars, lipids, and proteins, as well as to water [13,15].

The process of measurement consists of 1) spectral data obtained, 2) noise removal, 3) calibration model development through reference data, and 4) model assessment [19]. Data analysis is essential in conjunction with fundamentals and instruments, which constitute the first two pillars of NIR spectroscopy. The correlation between the distinct characteristics of the investigated sample and the transmittance or absorption values is established by analyzing data [1].

Machine Learning (ML) is the scientific field in which machines are trained to learn without being strictly programmed (Samuel, 2000). It includes three main categories: (1) supervised learning (SL), (2) unsupervised learning (UL), and (3) reinforcement learning (RL). ML applications in agricultural production systems comprise different categories: (a) crop management, (b) livestock management, (c) water management, and (d) soil management. ML models have been applied in the multidisciplinary agri-technologies domain for crop management (61%), yield prediction (20%), and disease detection (22%), but they have never specifically accounted for the co-occurrence of mycotoxins [20].

NIRS is now one of the most promising modern analytical techniques due to its non-invasiveness, speed, non-destructiveness, high throughput, minimal/straightforward sample preparation, chemical-free operation, instrument portability, and suitability for use by non-specialist operators. The technology has a strong outlook for further development due to advances in optics, computing power, and the recent wave of data science, AI, machine learning, and, more recently, deep learning. It allows several constituents to be measured simultaneously from a single spectrum. Therefore, this project aims to use NIRS in tandem with machine learning as a sustainable tool for mycotoxin assessment in cereals.

Methods

Wheat Samples

75 wheat samples were collected throughout the summer of 2022 from the central producing districts of Fieri, Elbasan, and Korça immediately after the harvest. The wheat samples were collected according to the sampling protocol and then stored in bags. Ultimately, they were transported to the laboratory and placed in a refrigerated chamber at 4°C in the dark until they were subjected to a physicochemical examination.

Physicochemical Analysis

The standard method for measuring grain protein content often uses near-infrared (NIR) spectroscopy, applied to whole, milled, or flour. This method relies on the connection between NIR spectroscopy and total nitrogen studies. Approximately 75 representative samples of the entire material were tested in the laboratory. The provided samples were utilized to calibrate a partial least squares regression (PLSR) model. This model was subsequently employed to predict the quantities of water, protein, starch, β -glucan, fat, and moisture.

Per the specifications outlined in Standard, the Infratec™ 1241 uses near-infrared wavelengths to analyze the kernel [21]. This enables the examination of various parameters, including fat, hydration, protein, gluten, sediment, and starch in whole kernels. The apparatus comprises the sample chamber, the monochromator light source, the wavelength selection processor, and the detector. A minimum bulk sample of 500 grams in weight is deposited into a hopper apparatus. The crucial data are generated in the reflectance mode over the 1100–2500 nm wavelength range. With greater light energy in the lower range, deeper penetration into the interior of the seed kernel is achievable [21].

Based on Beer's law, the methodologies used to examine optical data from absorbed samples can be characterized as various approaches to establish a correlation between analyte concentration and sample absorbance (A) at a specific wavelength.

For calibration, the multiple regression equation is utilized as follows:

$$Y = B_0 + B_i(-\log R_i)N + E$$

The variable Y represents the percent concentration of the absorber; B_0 equals the intercept of the regression; B_i is the regression coefficient; i = index of the utilized wavelength and reflectance (R_i) of that wavelength; N = number of wavelengths utilized in total for regression; E = random Error.

Results

As a rapid, non-destructive technique, near-infrared spectroscopy (NIR) has become increasingly popular for evaluating food and feed quality [1,16]. It provides decision-makers with a helpful tool to protect the quality of grain and the products associated with it during storage and processing. Seventy-five wheat samples from the 2022 harvest were analyzed using FOSS NIR equipment, Infratec™ 1241. The analyzed quality parameters included the protein content, moisture, starch content, gluten, and sedimentation index (Table 2).

Parameter	Min	Max	Mean
Proteins (%)	9.20	15.10	12.54 ± 1.27
Humidity (%)	9.50	12.20	10.86 ± 0.53
Starch (%)	66.80	72.00	69.59 ± 1.21
Gluten (%)	18.20	39.20	28.17 ± 4.34
Sedimentation index (cm ³)	19.20	59.00	39.35 ± 8.62

Table 2: Chemico-Physical Parameters in Wheat During the 2022 Harvesting Season (%)

The range of protein content was from 9.2 to 15.1%, with an average of 12.5% (Fig. 2). The near-infrared (NIR) examination of the starch in the wheat sample yielded a range of 66.8–72.0%, with an average value of 69.6% (Fig. 3). The gluten concentration ranged from 18.2 to 39.2%, with an average of 28.2%. The sedimentation index ranged from 19.2 to 59.0 cm³, with an average of 39.35 cm³ (Fig. 5). Optimal moisture levels are crucial for proper food storage. Elevated four moisture levels facilitate mold and worm proliferation throughout storage. As per EU law, the moisture content ranged from 9.5–12.2% in the wheat samples, and none exceeded the maximum threshold of 14.5%. The mean protein content was 12.54 ± 1.27%, with a maximum of 15.1%.

Figures



Figure 1: Foss Infrared Device (Infratec™ 1241)

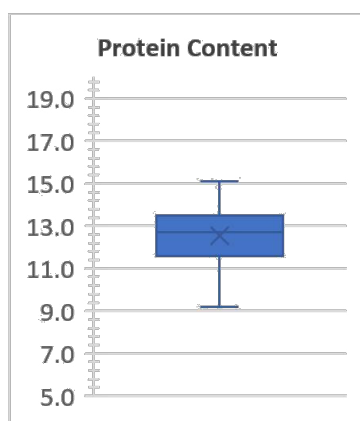


Figure 2: Protein Content in Wheat Samples (%)

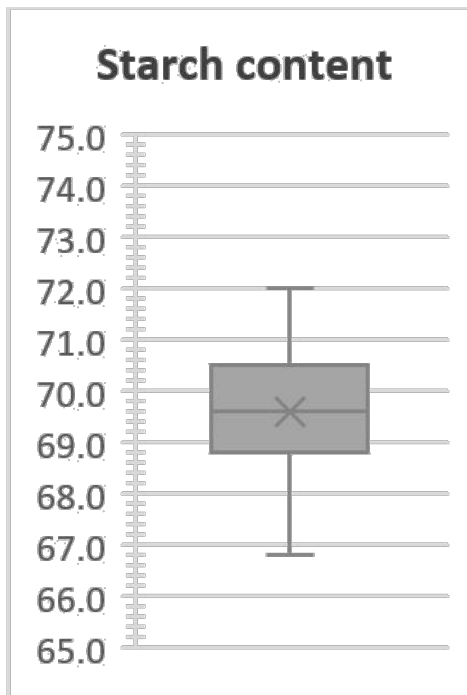


Figure 3: Starch Content in Wheat Samples (%)

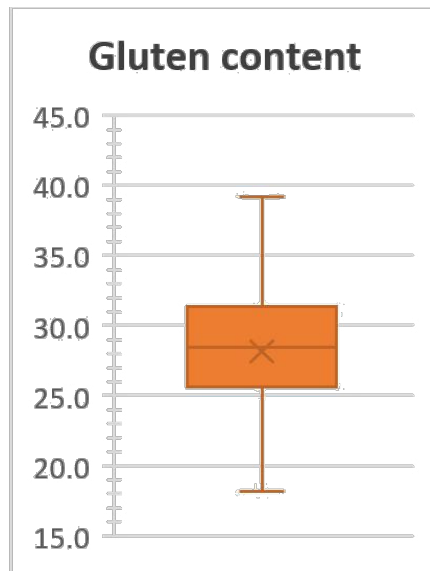


Figure 4: Gluten Content in Wheat Samples (%)

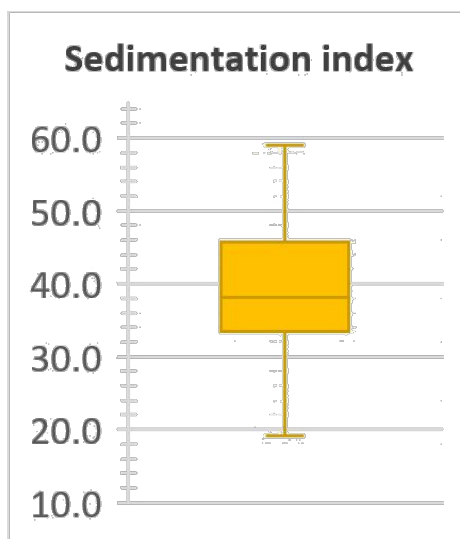


Figure 5: Sedimentation Index (cm³)

Discussions

This work aimed to apply NIR spectroscopy as a rapid technique for analyzing the physicochemical characteristics of wheat grain, including protein, gluten, starch, sedimentation index, and moisture, from wheat cultivated and consumed in Albania. Near-infrared spectroscopy (NIRS) has long been used in the food and agricultural industries to accurately assess protein levels in grains, particularly wheat. NIRS application in wheat quality control serves as an analytical tool to precisely determine grain composition and, secondly, as a fast, non-destructive technique during seed screening in the breeding process [15,22]. The successful measurement of wheat protein content is attributed to the robust and broad NIR absorption of N-H bonds [23]. The NIR monochromator with a 400–2500 nm range was used to scan entire grain samples for reflectance analysis. The Partial Least Squares (PLS) technique is applied to establish calibration equations for the qualitative attributes of whole wheat [24]. The advantage is the time and cost of completing the test in a few minutes. Compared to conventional laboratory methods, cost-effective tests use fewer solvents and other expensive equipment. This is particularly important in industrial-scale quality control [19,25].

The calibration model establishes a correlation between the spectral data and the molecule (or property) of interest. Formulating a NIRS calibration model is challenging due to the complex characteristics of the samples under examination. Consequently, numerous interference bands are generated, in which the characteristics or components of relevance tend to coincide. NIRS devices, chemometric approaches, and computer technology have significantly advanced NIRS methodology [22].

Gluten content is a key factor in evaluating wheat flour quality, as it correlates strongly with baking quality. Protein content, which can vary between 8–16%, alone does not consistently serve as a reliable indicator of baking quality, as fours with comparable protein content but distinct gluten compositions exhibit divergent baking characteristics [18]. Protein and glucose constitute the principal components of wheat flour, comprising 10–12% and 70–75%, respectively. Carbohydrates and lipids, on the other hand, are minor constituents, accounting for approximately 2% each [26]. During dough mixing, proteins undergo conformational changes, forming a three-dimensional structure that contributes to the strength and chewy texture of the final baked products.

The protein composition of several commonly consumed cereals exhibits variation. For instance, barley accounts for 9–12% of the total weight of the whole grain, maize for 8–12%, oats for 12–15%, rye for 12–15%, and wheat for 9–16%. The protein level of this wheat variety is higher (12–16%) than that of soft wheat, particularly durum wheat [5,27]. Protein content is assessed using several techniques (Table 3).

Process	Material assayed	Method
Mill	Grain/ Flour	NIR
Extract	Protein in solution	Biuret
Hydrolyze	Amino acids	Liquid chromatography
Alkaline digestion	Amide N	Titrate the ammonia released
Acid digestion	Ammonia or nitrogen	Kjeldahl method

Table 3: Methods Applied to Determine The Protein Content of Cereal Grain Wheat

Starch is the predominant macromolecule in plants, consisting of helical chains of glucose molecules linked by α -1,4 bonds and by α -1,6 bonds. It is present in the form of granules within the grain's endosperm. Starch consists of two primary components: amylose, composed of linear chains of α - (1–4)-linked glucose, and amylopectin, which is often the predominant component and consists of extensively branched polymers [3]. The near-infrared (NIR) measurement of starch in the examined wheat ranged from 66.8% to 72.0%, with an average of 69.6%.

Plant proteins account for almost 50% of the protein in our diet. The protein harvest comprises wheat, rice, and maize, the three primary cereal crops [27]. The gluten concentration ranged from 18.2% to 39.2%, with an average of 28.2%. The recommended threshold for the gluten content in wheat flour is around 24% when measured in its wet state [28]. Of the 76 wheat samples studied, just 4, which make up 5.3% of the total, had a gluten concentration below 24%. This suggests that the wheat produced in 2022 is of exceptional quality.

The sedimentation index ranged from 19.2 to 59.0 cm³, with an average of 39.35 cm³. This test is a scientific examination that provides valuable information about the baking properties of wheat flour. The Zeleny value measures the sedimentation rate of four suspended particles in a lactic acid solution over a given period. The Zeleny test value is employed to evaluate the quality of the baking process. Higher gluten content and improved gluten quality result in lower sedimentation rates and higher Zeleny test results [29].

Optimal moisture levels are crucial for proper food storage. Elevated four moisture levels facilitate mold and worm proliferation throughout storage. As per EU legislation, the moisture content ranged from 9.5–12.2% in the wheat samples, and none exceeded the maximum threshold of 14.5%. The mean protein content was $12.54 \pm 1.27\%$, with a maximum of 15.1%. A significant global food safety issue is the presence of mycotoxins in grains. The presence

of both controlled and non-regulated mycotoxins poses an ongoing risk to the global population, primarily because grains such as wheat and maize are essential staples in many diets. Prolonged exposure can result in various toxic and detrimental effects on specific organs. The problem of mycotoxin contamination in Albania has received attention, particularly in cereals [30,31]. However, NIR practitioners have focused on other components, such as aflatoxin in corn or deoxynivalenol in wheat, even though their natural concentrations are below the detection limits of NIR reflection or transmission spectroscopy at levels lower than one part per million (sub-ppm). [32,33].

Conclusions

The NIRS application analyzes quality indicators, including protein, gluten, starch, and sedimentation index, in whole-kernel wheat grown in Albania. Ensuring the quality of wheat and wheat flour is of significant economic importance in food safety and security. The use of NIR spectroscopy in a cereal quality study demonstrates that wheat commodity production in Albania exhibits exceptional quality. Climate change affects both the ability to produce enough food and the safety of grain production. An investigation of the physicochemical properties of wheat grain harvested in 2022, including protein, gluten, starch, sedimentation index, and moisture, found that protein content ranged from 9.2% to 15.1%, with an average of 12.5%. Four of the evaluated samples fell below the 10.5% threshold. Using affordable, easily transportable methods such as Near-Infrared Spectroscopy (NIRS), the chain from farms to the mill can enhance grain output and raise awareness of the economic significance of quality metrics.

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References:

1. Zhang, S., Liu, S., Shen, L., Chen, S., He, L., & Liu, A. (2022). Application of near-infrared spectroscopy for the nondestructive analysis of wheat flour: A review. *Current Research in Food Science*, 5, 1305-1312.
2. Preece, C., Livarda, A., Christin, P. A., Wallace, M., Martin, G., Charles, M., ... & Osborne, C. P. (2017). How did the domestication of Fertile Crescent grain crops increase their yields?. *Functional ecology*, 31(2), 387-397.
3. Wrigley, C. W. (2016). Wheat: an overview of the grain that provides' our daily bread'.
4. Giraldo, P., Benavente, E., Manzano-Agugliaro, F., & Gimenez, E. (2019). Worldwide research trends on wheat and barley: A bibliometric comparative analysis. *Agronomy*, 9(7), 352.
5. Williams, P. (2006). Grains and seeds. Ed by Y. Ozaki, McClure, W.F. & Christy, A.A. Wiley-Interscience, Hoboken, New Jersey, USA, pp. 165–217.
6. Iqbal, M. J., Shams, N., & Fatima, K. (2022). Nutritional quality of wheat. In *Wheat*. Rijeka, Croatia: IntechOpen.
7. Khalid, A., Hameed, A., & Tahir, M. F. (2023). Wheat quality: A review on chemical composition, nutritional attributes, grain anatomy, types, classification, and function of seed storage proteins in bread making quality. *Frontiers in Nutrition*, 10, 1053196.
8. Dzartova-Petrovska B, Hackaj, I, Lynch, B, Mackedon, J, Srivastava, J. P, Sutton, W. R. (2011). Albania - Climate change and agriculture country note (English). Climate change and agriculture country note, Washington, DC: World Bank Group. 95406, pp.16.
9. Diku A. (2011). The impact of climate change on food production/selected crop yields in Albania. In: Ivanyi, Z. (ed.). The impacts of climate change on food production in the Western Balkan Region. Report Regional Environmental Center for Central and Eastern Europe: 1–23.)
10. Gjeçi, G. R. I. G. O. R., Shytaj, F. E. S. T. I. M., & Biçoku, Y. L. L. I. (2018). Livestock sector in Albania: trends and challenges. *Albanian J Agric Sci*, 221-233.
11. FAOSTAT (2022). World production of wheat for 2021.
12. INSTAT (2022). Cereal production during 2021 in Albania.
13. Baeten, V., Pierna, J. F., Vermeulen, P., Lecler, B., Minet, O., Zio, D., & Dardenne, P. (2019, June). Performance comparison of bench-top, hyperspectral imaging and pocket near infrared spectrometers: The example of protein quantification in wheat flour. In *Proceedings of the 18th International Conference on Near Infrared Spectroscopy, Copenhagen, Denmark* (pp. 11-15).
14. Johnson, J. B. (2020). An overview of near-infrared spectroscopy (NIRS) for the detection of insect pests in stored grains. *Journal of Stored Products Research*, 86, 101558.
15. Delwiche SR. (2021). Grains, in Handbook of Near-Infrared Analysis, 4th Edition, Ed: Ciurczak, E. W., Igne, B., Workman, Jr, J., & Burns, D. A. CRC Press. Boca Raton, p. 627–642.
16. Kamruzzaman, M., ElMasry, G., Sun, D. W., & Allen, P. (2012). Non-destructive prediction and visualization of chemical composition in lamb meat using NIR hyperspectral imaging and multivariate regression. *Innovative Food Science & Emerging Technologies*, 16, 218-226.
17. Munck, L. (2019, April). The unreasonable effectiveness of near-infrared spectroscopy explained. Introducing the era of NIRS integrated functional finger-printing. In *Proc. 18th Int. Conf. Near Infrared Spectroscopy*, Ed by SB Engelsen, KM Sørensen and F. van den Berg. IM Publications Open, Chichester (pp.105-114).
18. Schuster, C., Huen, J., & Scherf, K. A. (2023). Prediction of wheat gluten composition via near-infrared spectroscopy. *Current Research in Food Science*, 6, 100471.
19. Cen, H., & He, Y. (2007). Theory and application of near infrared reflectance spectroscopy in determination of food quality. *Trends in Food Science & Technology*, 18(2), 72-83.
20. Liakos, K. G., Busato, P., Moshou, D., Pearson, S., & Bochtis, D. (2018). Machine learning in agriculture: A review.

21. EN 15948:2015: Cereals, Determination of Moisture and Protein, Method using Near-Infrared Spectroscopy in whole kernels.
22. Williams, P. (2008). Sampling, sample preparation, and sample selection. In Burns & Ciurczak (Eds.), *Handbook of near-infrared analysis*. Boca Raton: CRC Press Taylor & Francis Group. (pp. 267–295).
23. Caporaso, N., Whitworth, M. B., & Fisk, I. D. (2018). Protein content prediction in single wheat kernels using hyperspectral imaging. *Food chemistry*, 240, 32-42.
24. Pojić, M. M., & Mastilović, J. S. (2013). Near infrared spectroscopy—advanced analytical tool in wheat breeding, trade, and processing. *Food and Bioprocess Technology*, 6(2), 330-352.
25. Kahriman, F., & Egesel, C. Ö. (2016). Comparison of Spectral and Molecular Analyses for Classification of Long Term Stored Wheat Samples. *Guang pu xue yu Guang pu fen xi= Guang pu*, 36(4), 1266-1272.
26. Goesaert, H., Brijs, K., Veraverbeke, W. S., Courtin, C. M., Gebruers, K., & Delcour, J. A. (2005). Wheat flour constituents: how they impact bread quality, and how to impact their functionality. *Trends in food science & technology*, 16(1-3), 12-30.
27. Békés, F., & Wrigley, C. W. (2016). The protein chemistry of cereal grains.
28. Kaushik, R., Kumar, N., Sihag, M. K., & Ray, A. (2015). Isolation, characterization of wheat gluten and its regeneration properties. *Journal of food science and technology*, 52(9), 5930-5937.
29. Hrušková, M., & Faměra, O. (2003). Prediction of wheat and flour Zeleny sedimentation value using NIR technique. *Czech journal of food sciences*, 21(3), 91.
30. Topi, D., Jakovac-Strajn, B., Pavšič-Vrtač, K., & Tavčar-Kalcher, G. (2017). Occurrence of ergot alkaloids in wheat from Albania. *Food Additives & Contaminants: Part A*, 34(8), 1333-1343.
31. Topi, D., Babič, J., Jakovac-Strajn, B., & Tavčar-Kalcher, G. (2023). Incidence of aflatoxins and ochratoxin A in wheat and corn from Albania. *Toxins*, 15(9), 567.
32. Levasseur-Garcia, C. (2018). Updated overview of infrared spectroscopy methods for detecting mycotoxins on cereals (corn, wheat, and barley). *Toxins*, 10(1), 38.
33. Mato, L., Damani, Z., Spahiu, J., Halimi, E., Seiti, B., & Topi, D. (2024). High prevalence of mycotoxigenic fungi and Aflatoxin B1 contamination in corn and wheat grains grown to albania: implications for food safety. *Journal of food quality and hazards control*, 11(1), 59-68.
34. Commission Regulation (EC) No 687/2008 of 18 July 2008 establishes procedures for the taking over of cereals by intervention agencies or paying agencies, and lays down methods of analysis for determining the quality of cereals.
35. Topi, D., Damani, Z., Babič, J., Jakovac-Strajn, B., & Tavčar-Kalcher, G. (2024). The Presence of Some Minor Aspergillus and Penicillium Unregulated Mycotoxins in Main Cereals Cultivated in Albania. *Molecules*, 29(22), 5292.