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Original research paper

NUTRITIONAL CHARACTERIZATION AND REGIONAL VARIABILITY OF CORN GRAINS FOR MONOGASTRIC ANIMAL FEEDING IN WESTERN ROMANIA

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Abstract: The objective of this study was to evaluate the nutritional quality and variability of corn grains used in the diet of monogastric animals, with a focus on samples collected from three counties in western Romania: Timiș, Arad, and Caraș-Severin. The analyzed corn kernels, originating from the local hybrid Fundulea 350, were collected from regional grain collection centers after harvest and analyzed to determine their chemical composition, amino acid profiles, and energetic parameters relevant to swine and poultry nutrition. Near-infrared reflectance spectroscopy (NIR) was employed to assess dry matter, crude protein, ether extract, crude fiber, ash, starch, and the concentrations of essential and non-essential amino acids. The results revealed significant interregional differences. Dry matter content ranged from 85.40% (Caraș-Severin) to 90.50% (Timiș), indicating generally good preservation conditions. Crude protein concentrations exhibited marked variability between regions, with the highest values recorded in Timiș (up to 10.72%) and the lowest in Caraș-Severin (minimum 6.67%). Lysine levels varied between 0.213% and 0.312%, while methionine ranged from 0.167% to 0.219%. Total starch content was consistently high (61.9–66.6%), supporting substantial energy contributions. Metabolizable energy for growing pigs (ME_GP) ranged from 13.61 MJ/kg in Caraș-Severin samples to 14.62 MJ/kg in Timiș samples. All samples contained a high proportion of phytic phosphorus (74–76%), underscoring the need for phytase supplementation to improve phosphorus bioavailability. The variability observed among regions emphasizes the importance of locally specific nutrient analysis to inform precise diet formulation and optimize performance in monogastric animal production. These findings underscore the crucial role of regional nutrient profiling in facilitating precision diet formulation for swine and poultry production. Targeted selection and strategic blending of corn batches can improve protein supply, amino acid adequacy, and feed energy density, ultimately enhancing production efficiency and sustainability in monogastric systems.

Key words: *corn, nutrition, swine, poultry, NIR*

INTRODUCTION

Currently, increasing importance is given to the nutritional quality of raw materials used in the feeding of monogastric animals, particularly pigs and poultry (Barua et al., 2021; Li et al., 2014; Ruiz-Arias, Lee & Stein, 2024). Corn grain, the dominant cereal in feed rations for these species, represents the main source of energy and, to some extent,

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vegetable protein, making the detailed evaluation of its chemical composition and biological value essential for optimizing feed formulations (Ma et al., 2019; Partal, Oltenacu & Petcu, 2021; Radosavljevic, 2020).

Corn (*Zea mays* L.) is one of the most important cereal crops in Europe, used for human consumption, animal feeding, and bioenergy production, with an annual output exceeding 60 million tons. The main producers include France, Romania, Hungary, and Italy, with yields ranging from 6 to over 10 t/ha depending on agroecological conditions, hybrids, and agricultural management (Pinke et al., 2022; EUROSTAT, 2025). Digital technologies based on multispectral remote sensing and modeling algorithms are increasingly used for yield forecasting and optimizing management decisions (Sarkar et al., 2025). Additionally, biofertilization with nanofertilizers (<100 nm) and vermicompost has been shown to improve nutrient availability (N, P), nutrient use efficiency, and increase biomass and yield, particularly in calcareous soils (Oyege & Ba-laji Bhaskar, 2023).

In Romania, corn is the main agricultural crop, with over one million hectares cultivated annually, placing the country among the European Union leaders in total cultivated area, alongside France, Hungary, and Italy (Carbune, Voia, Pacala & Vidu, 2015; Ciobanu, Pop & Moraru, 2020; FAO, 2023). Between 2010 and 2022, the cultivated area ranged from 2.1 to 2.7 million hectares, while total production varied between 6 million tons (2012) and 18.7 million tons (2018), with yields ranging from 2.2 t/ha to 7.6 t/ha (FAO, 2025; EUROSTAT, 2025). Drought years such as 2015 and 2022 resulted in lower yields (3.5 and 3.3 t/ha), whereas favorable seasons in 2017 and 2021 generated over 14 million tons, and record values of 18.7 and 17.4 million tons were registered in 2018 and 2019 (FAO, 2021; EUROSTAT, 2025).

Corn, as a staple agricultural crop in Romania, holds significant importance due to the nutritional variability between regions and hybrids, which can substantially influence livestock performance, production costs, and the metabolic balance of animals (Carbune et al., 2015; Ciobanu et al., 2020). However, in many cases, the nutritional values used for feed formulation are based on average or estimated data, without local verification through specific laboratory analyses. This highlights the need to collect and interpret real data on the nutritional quality of corn grains depending on their geographic origin to support more precise, efficient, and sustainable feeding strategies (Pratikantam et al., 2024; Vargas, Gulizia, Bonilla, Sasia & Pacheco, 2023). The aim of this study was to evaluate the nutritional quality of corn grains used in the feeding of mono-gastric animals by determining their chemical composition, the profile of essential and non-essential amino acids, and relevant energy parameters. Samples were collected from three representative counties in western Romania—Timiș, Arad, and Caraș-Severin—to highlight interregional differences and propose nutritional recommendations tailored to geographic origin. The findings contribute to informed decision-making regarding the selection and optimal use of corn in feed formulations, with a focus on efficiency, digestibility, and protein balance.

MATERIALS AND METHODS

Sample collection and preparation

The study was conducted in accordance with the agricultural growing season of corn in Romania, between April and October 2024. The research focused on assessing the nutritional characteristics of corn grains from three counties in western Romania—Timiș (TM), Arad (AR), and Caraș-Severin (CS)—selected for their differences in topography and pedoclimatic conditions. A total of 60 samples (25 from Timiș, 19 from Arad, and 16 from Caraș-Severin) of corn kernels originated from the local hybrid Fundulea 350 were collected from regional grain collection centers after harvest. All samples were homogenized, ground to pass through a 1-mm sieve, and conditioned at room temperature before analysis to ensure uniformity.

Near-infrared (NIR) spectrometry

Laboratory analyses were performed using near-infrared (NIR) spectrometry with the AMINONIR® analyzer (Evonik Industries AG, Germany). The device operates on calibrated absorption spectra in the wavelength range of 850–2500 nm. Optical density (OD) detection was performed in reflectance mode, and calibration equations were based on standardized reference methods provided by Evonik. Calibration and validation were carried out with internal and external control samples, and accuracy was verified by comparison with wet chemistry reference data. The AMINONIR® software (Evonik Industries) was used for spectral processing, baseline correction, and statistical validation. This method enables the determination of amino acid content and major chemical compounds. Energy values of the corn grains for swine and poultry were also automatically calculated using the AMINONIR® software nutrient prediction module.

Soil and climatic characterization of the study regions

To establish correlations regarding the influence of regional soil fertility and pedoclimatic conditions on the nutritional composition of corn grains, estimated pedological data from specialized sources, as well as monthly average air temperature and precipitation values from April to October 2024, were analyzed using regional meteorological data-bases available online. For the general charac-terization of soils, the following information was obtained: Timiș County is characterized by predominantly low-altitude plains, chernozems prevail, with a neutral to slightly alkaline pH (6.5–7.5), humus content between 3.5–5.0%, total nitrogen 0.18–0.25%, available phosphorus 60–100 mg/kg, and available potassium 120–200 mg/kg (ESDAC, 2025; Lato et al., 2013). In Arad County, which features varied topography (plains, hills, and low mountains), soils are mainly chernozems and fluvisols, with a pH of 6.2–7.2, humus 3.0–4.5%, nitrogen 0.16–0.22%, phosphorus 50–90 mg/kg, and potassium 110–180 mg/kg (ESDAC, 2025; Vlad et al., 2007; Dicu, Tarau & Borza, 2012). In Caraș-Severin County, characterized by predominantly mountainous terrain, luvisols and cambisols are dominant, with a more acidic pH (5.5–6.5), humus content of 2.0–3.5%, total nitrogen 0.10–0.20%, phosphorus 30–70 mg/kg, and potassium 80–150 mg/kg (ESDAC, 2025; Dinca & Cantar, 2017). For the climatic characterization of the studied regions, it was observed that in Timiș County, average monthly temperatures ranged from 11 °C in April to 28 °C in July and August, with averages of approximately 24 °C in September and 18 °C in October. Precipitation levels were relatively moderate, with monthly values ranging from 42 mm in September to 83 mm in June, while April and October were the driest months, with 48 mm and 43 mm, respectively (Climate-data.org, 2024; ANM, 2024). In Arad County, temperature trends were similar, with averages between 11 °C in April and 30 °C in July–August, and monthly precipitation values between 46 mm and around 70 mm, with peaks recorded in May and June (Atlas Weather, 2024; ANM, 2024). In Caraș-Severin County, temperatures were slightly lower, with averages of 11 °C in April and 27–28 °C during the summer peak months. The pluviometric regime was considerably higher, with monthly precipitation exceeding 90 mm in June and July, and a maximum of 108 mm in June, characteristic of the mountainous and sub-mountainous areas of this county (Atlas Weather, 2024; ANM, 2024).

Statistical analysis

All data were statistically processed using ANOVA tests. Statistical correlations and descriptive statistics were also applied. Differences were considered statistically significant when $p \leq 0.05$. In addition, t-tests were used to assess pairwise comparisons, and positive or negative correlations were calculated.

RESULTS AND DISCUSSION

Chemical composition of corn

These investigations revealed notable variations among the three studied counties, suggesting possible influences of agroclimatic conditions on their nutritional values (Table 1). Dry matter content was slightly higher in Timiș (89.10%) and Arad (89.02%) compared to Caraș-Severin (86.58%), with a no statistically significant difference ($p > 0.05$), indicating higher moisture levels in the mountainous area. Crude protein content showed statistically significant differences ($p = 0.0136$), with higher values in Timiș (9.47%) and Arad (9.08%) than in Caraș-Severin (7.51%), suggesting more favorable conditions for protein accumulation in lowland regions. Parameters such as ether extract (3.50–3.90%), crude fiber (2.23–2.30%), crude ash (1.25–1.30%), starch (63.25–64.10%), sugars (1.93–2.05%), total phosphorus (2103.50–2283.14 mg/kg), and phytic phosphorus (1577.00–1700.43 mg/kg) showed no statistically significant differences ($p > 0.05$), indicating a relatively uniform composition of these nutrients.

Table 1.
Comparative chemical composition of corn by county

Parameter	Timiş (n=25)	Arad (n=19)	Caraş-Severin (n=16)	*p*-value
Dry matter (%)	89.10 ± 1.25	89.02 ± 1.10	86.58 ± 1.30	0.05
Crude protein (%)	9.47 ± 0.45	9.08 ± 0.40	7.51 ± 0.35	0.01
Ether extract (%)	3.50 ± 0.20	3.90 ± 0.25	3.65 ± 0.22	0.19
Crude fiber (%)	2.23 ± 0.15	2.23 ± 0.14	2.30 ± 0.18	0.93
Crude ash (%)	1.29 ± 0.09	1.30 ± 0.08	1.25 ± 0.10	0.88
Starch (%)	64.10 ± 2.10	63.47 ± 1.95	63.25 ± 2.00	0.79
Acid detergent fiber (ADF, %)	2.91 ± 0.20	3.07 ± 0.21	2.85 ± 0.19	0.47
Neutral detergent fiber (NDF, %)	10.76 ± 0.55	11.50 ± 0.60	11.50 ± 0.58	0.08
Sugar (%)	1.93 ± 0.12	2.03 ± 0.13	2.05 ± 0.11	0.58
Phosphorus (mg/kg)	2283.14 ± 85.5	2225.33 ± 80.2	2103.50 ± 78.9	0.30
Phytic phosphorus (mg/kg)	1700.43 ± 70.2	1669.33 ± 68.5	1577.00 ± 65.4	0.41

across the region. Detergent fibers (ADF and NDF) showed only slight variation trends among counties ($p \approx 0.089$).

The results show that, despite a general stability in the chemical composition of corn across the three counties, crude protein content was significantly influenced by region, being higher in the lowland counties, while natural moisture was slightly higher in Caraş-Severin, a marginally significant difference that may affect the storage and preservation of the raw material. These differences may have implycations for feed formulation and for determining the regional nutritional value of corn used in monogastric animal feeding.

Amino acid content of corn

The investigation of amino acid content of corn revealed notable differences among the three studied counties—Timiş, Arad, and Caraş-Severin—suggesting a significant influence of pedoclimatic and geographical conditions on the nutritional quality of plant protein (Fig. 1). Considering that crude protein content was higher in Timiş (9.47%) and Arad (9.08%) compared to Caraş-Severin (7.51%), the amino acid profile followed the same trend (Table 2). Among essential amino acids, methionine and cystine showed similar values in Timiş and Arad (0.19–0.20%) but lower levels in Caraş-Severin (0.16–0.17%), with a combined con-tent of 0.40% in lowland areas versus 0.32% in the mountainous region ($p = 0.19$). Lysine, threonine, and tryptophan exhibited compa-rable concentrations in lowland counties and slightly lower levels in Caraş-Severin. Leu-cine, valine, isoleucine, and phenylalanine were also higher in Timiş and Arad (e.g., leucine 1.08–1.09% vs. 0.85% in Caraş-Severin), indicating better protein quality.

Non-essential amino acids such as glutamic acid (1.71% in Timiş and 1.65% in Arad vs. 1.31% in Caraş-Severin), alanine (0.69–0.67% vs. 0.53%), proline (0.81% vs. 0.64%), and serine (0.45–0.44% vs. 0.35%) followed the same pattern. The sum of amino acids was 8.79%, 8.51%, and 6.92%, respectively ($p > 0.05$), confirming a higher nutritional potential of corn from lowland regions.

The differences identified among the three counties reflect the direct influence of environmental factors on the biological value of corn protein. This regional variability can have an important impact on feed formulation for monogastric animals and supports the need to adapt nutritional strategies according to the geographical origin of the raw materials used.

Analysis of the amino acid profile of corn with bioavailability for swine

In this study, the bioavailability refers to the proportion of amino acids that can be effecttively digested and absorbed by swine, expressed as standardized ileal digestibility (SID). This analysis revealed significant differences among corn samples collected from Timiş, Arad, and Caraş-Severin, reflecting the direct influence of local agroecological conditions on the nutritional profile of the kernels (Table 2). Methionine, an essential amino acid with a critical role in protein metabolism in swine, showed similar levels in Timiş and Arad (0.17%) but was significantly lower in Caraş-Severin (0.14%, $p \leq 0.05$). Cystine followed the same trend, with the combined methionine + cystine content being 0.34% in Timiş, 0.33% in Arad, and 0.27% in Caraş-Severin ($p \approx 0.063$). Lysine, the most important limiting essential amino acid in swine.

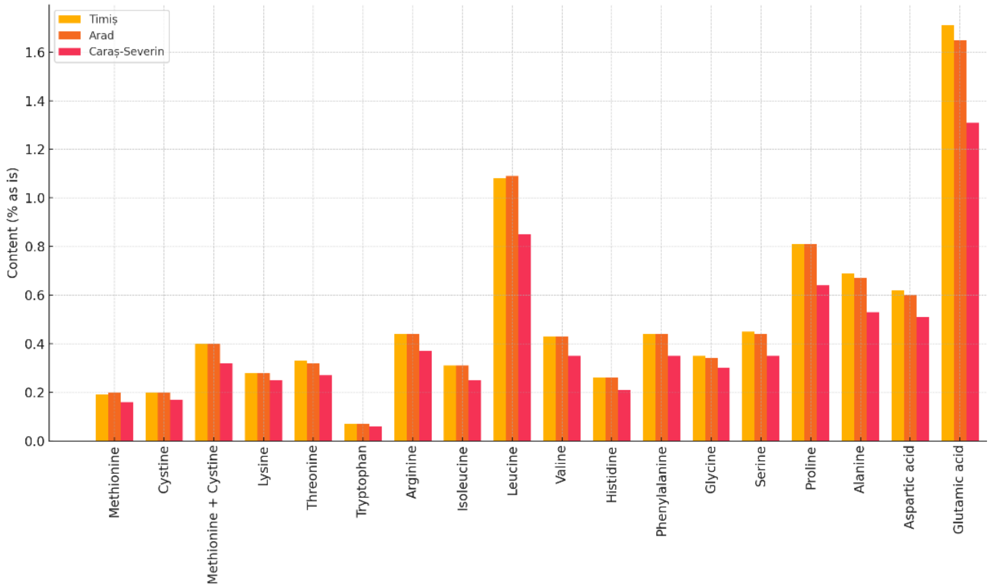

Figure 1. Comparative amino acids content of corn over the observed counties

Table 2.
Bioavailable amino acid content of corn for swine and poultry in Timiş, Arad, and Caraş-Severin counties

Parameter	Swine				Poultry			
	Content (% as is)				Content (% as is)			
	Mean TM	**Mean AR**	**Mean CS**	*p*-value	**Mean TM**	**Mean AR**	**Mean CS**	*p*-value
Methionine	0.17	0.17	0.14	0.03	0.20	0.18	0.15	0.12
Cystine	0.17	0.16	0.13	0.12	0.19	0.17	0.14	0.26
Methionine + Cystine	0.34	0.33	0.27	0.06	0.39	0.36	0.29	0.19
Lysine	0.22	0.21	0.19	0.27	0.27	0.25	0.22	0.37
Threonine	0.27	0.25	0.21	0.19	0.32	0.28	0.23	0.30
Tryptophan	0.05	0.05	0.04	0.34	0.07	0.06	0.05	0.22
Arginine	0.39	0.38	0.33	0.07	0.43	0.39	0.33	0.32
Isoleucine	0.27	0.26	0.21	0.03	0.32	0.30	0.24	0.19
Leucine	0.95	0.96	0.74	0.00	1.08	1.00	0.78	0.13
Valine	0.36	0.35	0.29	0.01	0.44	0.40	0.33	0.22
Histidine	0.22	0.22	0.18	0.06	0.26	0.24	0.20	0.17
Phenylalanine	0.39	0.38	0.30	0.01	0.45	0.40	0.32	0.22
Glycine	0.30	0.29	0.26	0.04	0.33	0.29	0.26	0.36
Serine	0.39	0.37	0.30	0.01	0.47	0.43	0.35	0.21
Proline	0.74	0.76	0.60	0.01	0.83	0.76	0.60	0.22
Alanine	0.59	0.57	0.45	0.00	0.69	0.61	0.49	0.21
Aspartic acid	0.51	0.48	0.41	0.01	0.62	0.54	0.46	0.26
Glutamic acid	1.50	1.45	1.15	0.00	1.78	1.60	1.27	0.20

TM=Timiş; AR=Arad; CS=Caraş-Severin

nutrition, was present at similar levels in Timiș (0.22%) and Arad (0.21%) but was slightly reduced in Caraș-Severin (0.19%), without statistically significant differences ($p = 0.274560$), though biologically relevant in feed formulation. Similarly, threonine and tryptophan remained relatively constant among counties but were slightly lower in the mountainous area. Isoleucine, leucine, valine, and phenylalanine exhibited significant reductions

in Caraș-Severin (e.g., leucine 0.74% vs. 0.95–0.96% in lowland areas, $p < 0.001$), indicating lower protein potential. Histidine was also lower in the mountainous region (0.18% vs. 0.22%, $p \approx 0.059$). Similar differences were observed for non-essential amino acids. Glycine, serine, and proline had reduced levels in Caraș-Severin (proline 0.60% vs. 0.74–0.76%, $p = 0.0053$), while alanine and aspartic acid also showed significant decreases (alanine 0.45% vs. 0.59%, $p = 0.0016$). Glutamic acid, the most abundant amino acid in corn, reached 1.15% in the mountainous region compared to 1.50–1.45% in lowland areas, with a highly signi-ficant difference ($p<0.05$), reinforcing the fin-ding that corn from lowland regions has a superior protein potential compared to that cultivated in mountainous areas.

The distribution of bioavailable amino acids for swine confirms that corn cultivated in Timiș and Arad provides a more balanced nutritional profile better suited to the physiological requirements of swine, whereas corn from Caraș-Severin—likely affected by higher altitude, lower temperatures, and reduced soil fertility—contains significantly lower levels of most essential amino acids. These findings are relevant for optimizing feed formulations based on the geographical source of corn and ensuring adequate amino acid bioavailability in swine nutrition.

Analysis of the amino acid profile of corn with bioavailability for poultry

For corn collected from Timiș, Arad, and Caraș-Severin counties, clear differences were observed among the three regions, suggesting the influence of terrain, climate, and soil fertility on the nutritional value of the kernels (Table 2). Methionine, one of the most important amino acids for poultry due to its essential role in protein synthesis and energy metabolism, as well as cystine, had higher levels in Timiș (0.20% and 0.19%) compared to Caraș-Severin (0.15% and 0.14%), with total sulfur amino acids reaching 0.39% in lowland areas versus 0.29% in the mountainous region ($p \approx 0.20$). Lysine, threonine, and tryptophan also showed higher concentrations in Timiș (0.27%, 0.32%, and 0.07%) than in Caraș-Severin (0.22%, 0.23%, and 0.05%), indicating superior bioavailability in plains. Amino acids involved in muscle protein synthesis (isoleucine, leucine, and valine) were significantly higher in Timiș and Arad, with leucine reaching 1.08% in Timiș compared to 0.78% in Caraș-Severin. Histidine and phenylalanine followed the same trend (0.26% and 0.45% in Timiș versus 0.20% and 0.32% in Caraș-Severin). Among non-essential amino acids, glycine, serine, proline, and alanine had higher values in lowland regions (0.29–0.83%) compared to Caraș-Severin (0.26–0.60%). Additionally, aspartic and glutamic acids, important for nitrogen metabolism and digestive function in poultry, showed the highest values in Timiș (0.62% and 1.78%), while being significantly lower in Caraș-Severin (0.46% and 1.27%).

It can be observed that corn cultivated in Timiș and Arad counties presents a more balanced and nutritionally valuable amino acid profile for poultry compared to that harvested from Caraș-Severin. This difference is attributed to more favorable agroecological conditions in lowland regions, which support more efficient protein synthesis and, consequently, higher bioavailability of both essential and non-essential amino acids. Although most differences were not statistically significant, p-values close to the significance threshold, combined with the amplitude of the variations, biologically justify the regional influence on corn's nutritional quality, which has direct implications for optimizing poultry feed formulations based on the geographical source of the raw material.

Analysis of energy values of corn with bioavailability for swine

The analysis of energy values revealed clear differences among the three regions, reflecting the influence of pedoclimatic conditions on the energy content of the raw material intended for swine feeding (Fig. 2). Gross energy was

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higher in Timiș (16.72 MJ/kg; 3994 kcal/kg) and Arad (16.69 MJ/kg; 3987 kcal/kg) compared to Caraș-Severin (16.11 MJ/kg; 3848 kcal/kg), with significant differences ($p \approx 0.0013$). A similar trend was observed for digestible and metabolizable energy, both in growing pigs and sows. Digestible energy ranged from 14.81 MJ/kg in Timiș to 14.16 MJ/kg in Caraș-Severin ($p \approx 0.012$), while metabolizable energy ranged from 14.47 MJ/kg to 13.95 MJ/kg ($p \approx 0.028$). Net energy values were 11.42 MJ/kg in Timiș and 11.03 MJ/kg in Caraș-Severin for growing pigs ($p \approx 0.029$), and 11.77 MJ/kg versus 11.39 MJ/kg for sows ($p \approx 0.023$).

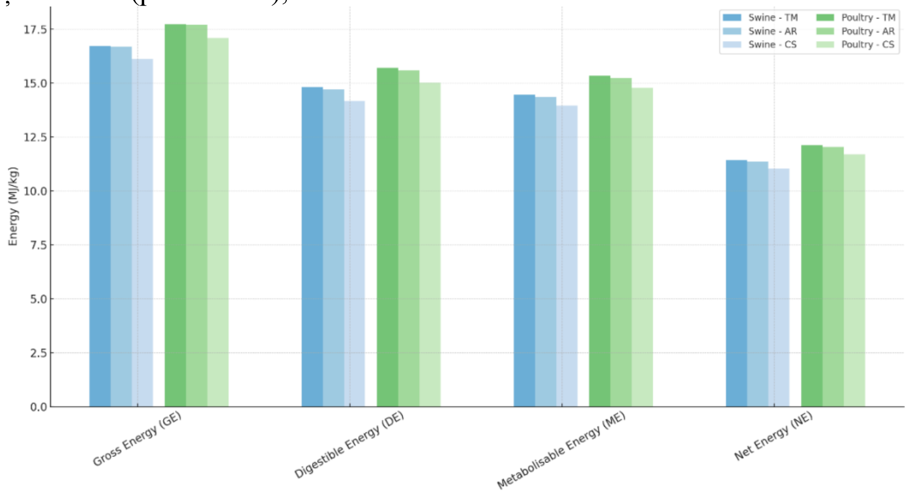

Figure 2. Comparative energy values of corn for swine and poultry by county

Corrected apparent metabolizable energy (AMEn) was also higher in lowland regions (14.11–14.07 MJ/kg) compared to the mountainous region (13.64 MJ/kg), with a significant difference ($p \approx 0.005$).

The overall results highlight that corn cultivated in Timiș and Arad counties demonstrates superior energy values, regardless of the type of energy measured, compared to corn from Caraș-Severin. Statistically significant differences across all analyzed energy forms suggest a major influence of geographic and climatic conditions on the energetic potential of corn, with direct implications for feed efficiency in swine nutrition. Corn from lowland regions provides higher energy bioavailability, making it technologically and economically more valuable for monogastric feeding.

Analysis of energy values of corn with bioavailability for swine and poultry

The comparative analysis revealed significant variations among the three counties, supported both by mean values and statistical significance (Fig. 2). Gross energy was higher in Timiș (17.72 MJ/kg; 4233.79 kcal/kg) and Arad (17.69 MJ/kg; 4226.57 kcal/kg) compared to Caraș-Severin (17.08 MJ/kg; 4078.88 kcal/kg), with statistically significant differences ($p \approx 0.0013$). A similar trend was observed for digestible energy (DE_GP: 15.70 vs. 15.01 MJ/kg; $p \approx 0.012$), metabolizable energy (ME_GP: 15.34 vs. 14.79 MJ/kg; $p \approx 0.029$), and net energy (NE_GP: 12.11 vs. 11.69 MJ/kg; $p \approx 0.030$), with higher values in lowland areas. Corrected apparent metabolizable energy (AMEn) was also higher in Timiș and Arad (≈ 14.9 MJ/kg) compared to Caraș-Severin (14.46 MJ/kg, $p \approx 0.005$).

These findings indicate a clear differentiation among the analyzed counties, with a distinct energetic advantage for corn from Timiș and Arad compared to Caraș-Severin. All analyzed energy forms, from gross to net energy and corrected metabolizable energy, followed the same decreasing trend according to topography and agroclimatic conditions. The results emphasize the importance of regionalizing raw material sourcing for poultry feeding and the need to adjust feed formulations based on the actual energetic potential of the corn used.

The correlative analysis between the chemical composition and amino acid profile of corn and pedoclimatic factors reveals a direct relationship between soil fertility, climatic conditions, and the nutritional value of corn. Fertile lowland soils, richer in organic matter and nutrients, support higher crude protein accumulation and a more balanced amino acid profile. In these regions, corn tends to exhibit increased levels of essential amino acids such as methionine, lysine, and leucine, enhancing the biological value of the protein. Conversely, more acidic and less fertile soils in mountainous areas are associated with lower protein content and reduced concentrations of several essential amino acids. This effect is amplified by specific climatic conditions—lower temperatures and higher precipitation—that can delay crop maturation and limit protein synthesis.

Overall, the correlations indicate that soil fertility (especially nitrogen and phosphorus availability) and warmer thermal regimes contribute to increased protein levels and richer amino acid profiles. Areas with acidic soils, lower fertility, and abundant rainfall tend to produce corn with reduced protein and amino acid content, which has implications for feed formulation and nutritional optimization for monogastric animals, as well as for establishing agricultural and livestock management strategies adapted to local conditions.

The analysis of bioavailable amino acid profiles and energy values of corn in Timiș, Arad, and Caraș-Severin counties confirms the significant influence of pedoclimatic factors on nutritional value, a finding supported by recent literature. Although Romanian studies directly addressing corn amino acids are limited, regional research on plant nutrition and animal feeding supports these observations.

Kil et al. (2014) demonstrated through standardized ileal digestibility determinations that corn has higher amino acid and energy bioavailability compared to high-fiber distillers dried grains with solubles (DDGS), supporting the superior amino acid profile found in our samples from Timiș and Arad. Similarly, Acosta, Espinosa, Jaworski and Stein (2021) reported higher concentrations of digestible and metabolizable energy in corn proteins compared to DDGS, confirming corn as a valuable energy source for swine—aligned with the clear regional differences observed in our study. On a global scale, trend analyses such as those conducted by Shirley et al. (2020) have highlighted the relationship between climatic variations (temperature and precipitation) and corn yield/nutritional composition, correlations that are mirrored in the differences between lowland and mountainous areas in our findings. Agricultural research worldwide on heat-stress tolerance in corn (Kornprobst & Davison, 2020) has shown that environmental variations directly affect protein and carbohydrate content, supporting the model where the warmer and drier climate of Timiș and Arad favors protein and amino acid accumulation.

Romanian studies are more limited, yet a report by INCDBNA (2017) on animal nutrition within the agronomic context emphasized the role of fertile soils and proper agricultural management in maximizing protein value and amino acid digestibility in feedstuffs, results that justify the influence of more productive soils in Timiș and Arad on corn composition.

Overall, this study clearly demonstrates that regional variability in the chemical composition and amino acid profile of corn is strongly influenced by soil and climatic factors, leading to significant differences in the nutritional value of raw material for monogastric animal feeding. Comparison with findings from the scientific literature confirms that fertile soils, higher temperatures, and moderate rainfall favour the accumulation of proteins and essential amino acids as well as superior energy availability in corn, while mountainous areas with more acidic soils and cooler, wetter climates limit these processes.

These findings underline the need to adapt nutritional strategies and feed formulations based on the geographic origin of corn, contributing to improved production efficiency and resource utilization in livestock farming.

CONCLUSIONS

The study highlighted significant differences in the chemical composition, amino acid profile, and energy values of corn originating from Timiș, Arad, and Caraș-Severin counties, primarily driven by pedoclimatic variability and soil characteristics. Corn cultivated in the lowland areas of Timiș and Arad demonstrated superior nutritional value compared to that from the mountainous region of Caraș-Severin, where more acidic soils, reduced fertility, and a wetter climate limited protein accumulation and essential amino acid content. These findings emphasize the importance of considering the geographic origin of corn when formulating feed recipes and recommend the development of regionally adapted strategies, including tailored agricultural practices and genetic improvement programs, aimed at enhancing the nutritional quality of corn in lower-potential areas, thereby improving animal nutrition efficiency and contributing to the sustainable growth of livestock productivity.

AUTHOR CONTRIBUTIONS

Conceptualization, I.H. and M.A.; Methodology, A-M.P. and M.A.; Investigation, formal analysis, validation, writing-original draft preparation, A-M.P., I.H. and E.T.; Writing-review and editing, A-M.P. and I.H.; Supervision, E.T.

DATA AVAILABILITY STATEMENT

Data contained within the article.

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NUTRITIVNA KARAKTERIZACIJA I REGIONALNA VARIJABILNOST KUKURUZNOG ZRNA ZA ISHRANU MONOGASTRIČNIH ŽIVOTINJA U ZAPADNOJ RUMUNIJI

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Sažetak: Cilj ove studije bio je da se proceni nutritivni kvalitet i varijabilnost kukuruznog zrna koje se koristi u ishrani monogastričnih životinja, sa fokusom na uzorke prikupljene iz tri okruga u zapadnoj Rumuniji: Timiš, Arad i Karaš-Severin. Analizirana zrna kukuruza, poreklom od lokalnog hibrida Fundulea 350, prikupljena su iz regionalnih centara za otkup žitarica nakon žetve i analizirana radi utvrđivanja njihovog hemijskog sastava, profila aminokiselina i energetskih parametara relevantnih za ishranu svinja i živine. Spektroskopija bliske infracrvene refleksije (NIR) korišćena je za procenu sadržaja suve materije, sirovih proteina, etarskog ekstrakta, sirovih vlakana, pepela, skroba, kao i koncentracije esencijalnih i neesencijalnih aminokiselina. Rezultati su pokazali značajne međuregionalne razlike. Sadržaj suve materije kretao se od 85,40% (Karaš-Severin) do 90,50% (Timiš), što ukazuje na generalno dobre uslove skladištenja. Koncentracije sirovih proteina pokazale su izraženu varijabilnost između regiona, pri čemu su najviše vrednosti zabeležene u Timišu (do 10,72%), a najniže u Karaš-Severinu (minimalno 6,67%). Nivoi lizina varirali su između 0,213% i 0,312%, dok se metionin kretao od 0,167% do 0,219%. Ukupan sadržaj skroba bio je konstantno visok (61,9–66,6%), što potvrđuje značajan energetski doprinos. Metabolizujuća energija za prasad u porastu (ME_GP) kretala se od 13,61 MJ/kg u uzorcima iz Karaš-Severina do 14,62 MJ/kg u uzorcima iz Timiša. Svi uzorci sadržali su visok udeo fitinskog fosfora (74–76%), što naglašava potrebu za suplementacijom fitazom radi poboljšanja biodostupnosti fosfora. Uočena varijabilnost između regiona ističe značaj lokalno specifičnih analiza hranljivih materija kako bi se omogućila precizna formulacija obroka i optimizovala proizvodnja monogastričnih životinja. Ovi nalazi naglašavaju ključnu ulogu regionalnog nutritivnog profilisanja u omogućavanju precizne formulacije obroka za svinje i živinu. Ciljano odabiranje i strateško mešanje partija kukuruza mogu poboljšati snabdevanje proteinima, adekvatnost aminokiselina i energetsku gustinu hrane, čime se unapređuju efikasnost proizvodnje i održivost monogastričnih sistema.

Ključne reči: *kukuruz, ishrana, svinje, živina, NIR*

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