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STARCH AND PROTEIN CONTENT IN NINE MAIZE CULTIVARS (*ZEA MAYS* L.)

Popoviciu Dan Răzvan, Stroe Traian-Ciprian*, Panaitescu Liliana
„Ovidius" University of Constanţa, Faculty of Natural Sciences and Agricultural Sciences, Constanţa, Romania
** Correspondence author. E-mail: str_ciprian@yahoo.com*

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ABSTRACT

Grains from nine maize cultivars locally grown in Constanța county were analyzed for starch and protein content, using spectrophotometric methods: P 0023, P 0216, P 0710 and P 9415, DKC 4109, DKC 4391, DKC 5810, KWS 4484, and SY Torino.
Starch concentration ranged from 60.40 % to 74.19 %, with the highest value recorded in P 0216 and the lowest in DKC 5810. Protein concentration ranged from 9.47 % to 10.54 %, with the highest value recorded in P 0023.

INTRODUCTION

Maize or corn (*Zea mays* L.) is one of the most important crop plants grown worldwide, also being grown on large areas in Romania.

Maize grains exhibit a diverse biochemical composition, containing a wide range of phytochemicals, including phenolic compounds, flavonoids, carotenoids, and other bioactive substances (Popoviciu et al. 2024, Popoviciu et al. 2025). These compounds contribute to the nutritional properties and antioxidant potential of maize grains (Radu et al. 2025). Nevertheless, starch and proteins remain the major constituents of maize grains, playing an important role in their nutritional and technological properties (Singh et al. 2013).

Starch is found in the parenchymatic cells of the endosperm, as 1-20 µm granules. The main constituent is amylopectin (branched glucose polymers) making up most of its biomass. Its properties, such as gelatinization temperature, crystallinity and digestibility vary among cultivars, especially between sugary and waxy varieties. Yet, maize starch is easier to digest than that in other cereals and exhibits a lower glycemic index (Singh et al. 2013).

Proteins form around 9-10 % of the grain biomass, a content comparable to other cereals. Albumins, globulins, glutelins and especially prolamins are the main protein classes. However, unlike other cereals, most of the proteic fraction in maize is represented by the prolamin zein, lacking two essential amino acids: tryptophan and lysine, giving it a lower nutritional value (Maqbool et al. 2021).

The biochemical composition of maize grains may vary depending on the hybrid and growing conditions. Previous research conducted under sprinkler irrigation in South-Eastern Romania examined the effects of hybrid, climatic variability, and

tillage practices on maize grain quality (Panaitescu et al. 2026). These findings provide a relevant context for further investigations into the starch and protein concentrations of maize hybrids cultivated under local agricultural conditions.

The aim of this paper was to comparatively assess the starch and protein contents in nine maize hybrid cultivars commonly grown in Southeastern Romania.

MATERIAL AND METHODS

The nine maize hybrids investigated in this study were P 0023, P 0216, P 0710, P 9415, DKC 4109, DKC 4391, DKC 5810, KWS 4484, and SY Torino. Grain samples were collected in 2024 from local farms in Constanța County and transported to Ovidius University of Constanța for laboratory analyses.

The main agronomic and morphological characteristics of the nine maize hybrids, based on information provided by the producers and available literature, are summarized in Table 1.

Table 1.

Main agronomic and morphological characteristics of the nine maize hybrids investigated in this study.

Hybrid	Producer	FAO group	Main characteristics
P 0023	Pioneer	400	Medium-sized, semi-late hybrid with medium ear insertion, compact ears, dent-type kernels, drought resistance, and good grain drying at maturity. Thousand-grain weight: 340–395 g.
P 0216	Pioneer	450	Semi-late, drought-resistant hybrid with a strong root system, high ear insertion, dent-type kernels, and resistance to corn smut. Thousand-grain weight: 365–400 g.
P 0710	Pioneer	450	Semi-late hybrid with a deep root system, good drought tolerance, and lodging resistance. Adapted to eroded soils. Thousand-grain weight: 430–450 g.
P 9415	Pioneer	340	Semi-early hybrid with drought tolerance and adaptation to acidic soils. Thousand-grain weight: 355–395 g.
DKC 4109	Bayer (DEKALB)	300–340	Early hybrid with medium flowering time, drought resistance, low to medium ear insertion, and dent-type kernels. Adapted to a wide range of climatic conditions and planting densities.
DKC 4391	Bayer (DEKALB)	300–340	Early hybrid with characteristics similar to DKC 4109 and a higher grain drying rate.
DKC 5810	Bayer (DEKALB)	450–490	Late hybrid with good disease resistance and high flowering capacity.
KWS 4484	KWS	380	Early-to-medium maturity hybrid with tall plants, long ears, an average number of kernels per ear, drought tolerance, and lodging resistance.
SY Torino	Syngenta	300–340	Early hybrid adapted to medium-input cultivation systems, with high yield potential and a good grain drying rate.

The farms were located in the central Cernavodă Plateau, along the middle course of the Carasu Valley, an area characterized by calcareous chernozem soils. In

2024, the mean annual temperature was 14.8 °C, compared with the long-term average of 11.6 °C, while annual precipitation reached 318.10 mm, below the long-term average of 436 mm. All nine hybrids were cultivated under sprinkler irrigation, with three irrigation applications of 400 m^3 ha^{-1} each. The grain samples collected from the nine maize hybrids were used to determine starch and protein concentrations under laboratory conditions. Each hybrid was analyzed separately to allow comparisons of grain biochemical composition among the investigated cultivars.

Previous studies have reported the presence of bioactive compounds and antioxidant activity in the investigated maize cultivars (Popoviciu et al. 2024, Popoviciu et al. 2025, Radu et al. 2025).

Prior to analysis, grain samples were ground using an electric grinder to obtain a fine flour. The flour was extracted with a 70 % ethanol solution by manual grinding and filtration to obtain an extract containing 10 % plant material (Robertson & Cao 2004; Radu et al. 2025).

Starch concentration was determined by measuring spectrophotometric absorbance at 580 nm against a 70 % ethanol blank using an ONDA UV-21 spectrophotometer. Concentration (mg/L) was calculated as 212.9×A580–43.08 (Vähäsalo & Holmbom 2004).

The total concentration of proteins was determined using the Warburg-Christiaan method: the spectrophotometric absorbance of the mixture was read at 260 and 280 nm. Concentration (mg/L) was calculated as 1.55×A280–0.76×A260 (Manchester 1996). All concentrations were then expressed as % DW.

Statistical analyses for this study included analysis of variance (ANOVA), for determining the significance of quantitative differences among samples, followed by the post hoc Tukey's Test to assess specific differences between pairs of samples. All were conducted using IBM SPSS software (version 30.0.0.0).

RESULTS AND DISCUSSIONS

The percentual contents of starch in maize grains are shown in Figure 1, while Figure 2 shows the average protein contents in the selected maize cultivars.

Results show that high starch contents were found in P 0216 (maximum: 74.19 %), DKC 4109, KWS 4484 and P 0023. At the other end, the lowest concentration was found in DKC 5810 (60.40 %), while other low concentrations (66-67 %) were found in P 0710, P 9415, SY Torino.

Differences between the nine cultivars were statistically significant ($F > 376$, $p < 0.001$). Similarity was found between P 0023, P 0216, DKC 4109 and KWS 4484, one one hand, and P 0710, P 9415 and SY Torino.

Protein contents had a narrower variation range. All four Pioneer hybrids had concentrations above 10 % (maximum in P 0023: 10.54 %). The lowest value was 9.47 % (KWS 4484).

Differences between the nine cultivars were also statistically significant ($F > 669$, $p < 0.001$). Similarity was found between KWS 4484 and SY Torino. The variation observed in starch and protein concentrations indicates that the investigated maize hybrids differed in their grain biochemical composition under the growing conditions of the study. The hybrid with the highest starch concentration (P 0216) was not the same as the hybrid with the highest protein concentration (P 0023), suggesting that the two grain constituents should be considered separately when comparing the nutritional composition of maize hybrids. These results provide

a basis for identifying differences in grain composition among the cultivars investigated under local agricultural conditions.

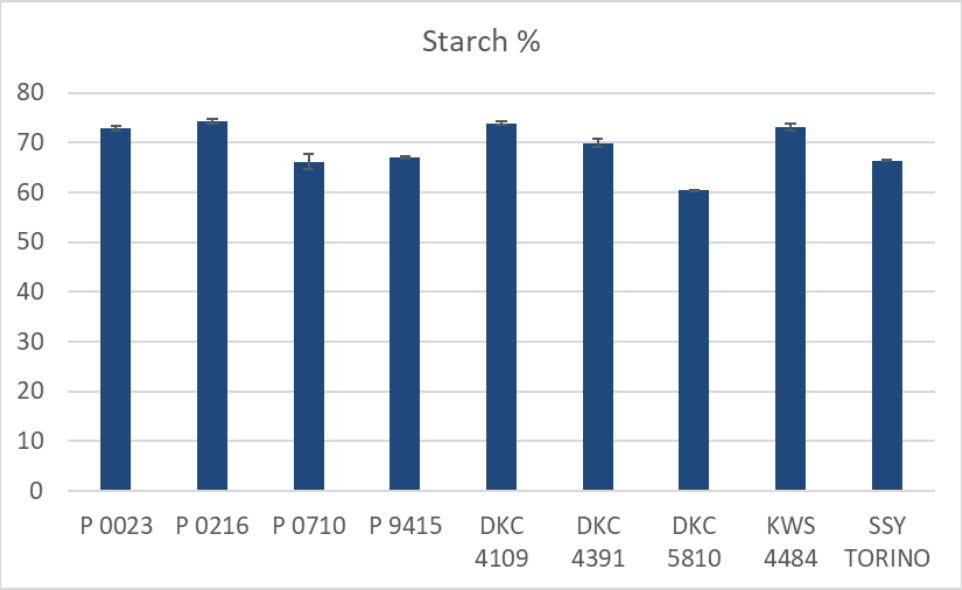


Figure 1. Starch concentrations in selected maize hybrids (%DW).

While most maize cultivars have starch contents close to 70 % or over, this character is extremely variable. A study on several Turkish cultivars found 45.02-84.73 % (Orak 2006). 62.15-85.78 % were found in Bangladeshi varieties (Tabassum et al. 2025), 58.80-75.30 % in Russian ones (Khatefov et al. 2023).

The starch concentrations recorded in the present study (60.40–74.19 %) fell within the ranges reported for maize cultivars in Turkey, Bangladesh, and Russia. The differences observed among the nine investigated hybrids highlight the variability of this grain constituent under the growing conditions of the study. Although several hybrids exhibited starch concentrations close to or above 70 %, the lower value recorded in DKC 5810 indicates that starch concentration should be considered individually when comparing the biochemical composition of maize hybrids.

The results also indicate that hybrids belonging to the same commercial group did not necessarily exhibit identical starch concentrations. Among the four Pioneer hybrids, P 0216 and P 0023 showed relatively high starch concentrations, whereas lower values were recorded in P 0710 and P 9415. A similar variation was observed among the DEKALB hybrids, with DKC 4109 exhibiting a relatively high starch concentration and DKC 5810 recording the lowest value in the study. These differences underline the importance of evaluating individual hybrids when assessing maize grain composition.

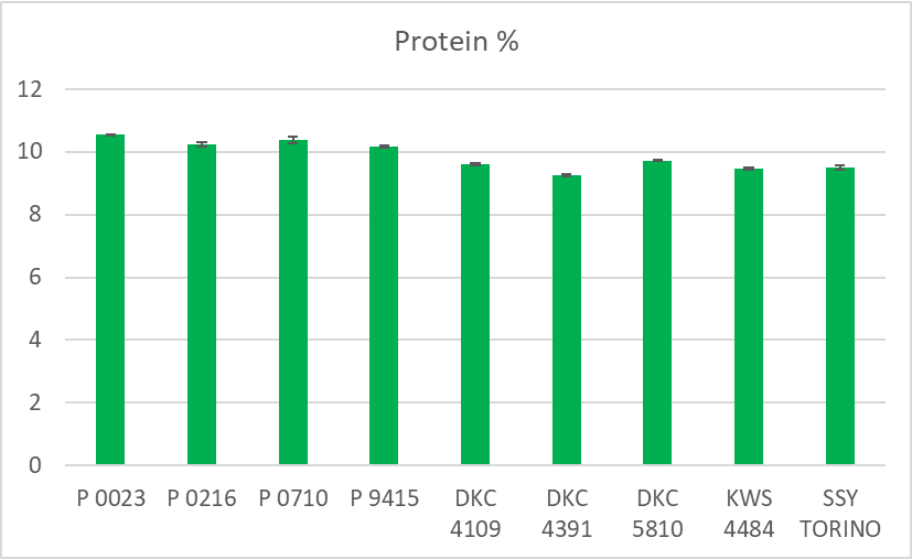


Figure 2. Protein concentrations in selected maize hybrids (%DW).

Maize protein is also variable. A study on Indian cultivars found 8.24-11.60 % total protein (Yadav et al. 2020), one in Malawi, 8.30-12.60 % (Muleya et al. 2023), one in Nigeria, 10.57-19.33 % with the higher values in quality protein maize (QPM) varieties (Olowookere et al. 2017). However, besides cultivar, literature shows that local conditions, climate factors and fertilization schemes can greatly influence this parameter, causing major differences even between successive growing seasons.

The protein concentrations recorded in the present study (9.47–10.54 %) fall within the ranges reported for maize cultivars in India and Malawi, while remaining below the upper values reported for the Nigerian cultivars. Although statistically significant differences were observed among the nine hybrids investigated, these results reflect grain composition under the specific growing conditions of the 2024 season. Further investigations across multiple growing seasons would be useful to assess the consistency of these differences under varying climatic and agricultural conditions.

CONCLUSIONS

Starch concentration varied among the nine maize hybrids, ranging from 60.40 % to 74.19 %. P 0216 exhibited the highest starch concentration, followed by DKC 4109, KWS 4484, and P 0023, whereas DKC 5810 exhibited the lowest concentration. Relatively lower starch concentrations were also recorded in P 0710, P 9415, and SY Torino.

Protein concentration showed a narrower range of variation, from 9.47 % to 10.54 %. The highest value was recorded in P 0023, while all four Pioneer hybrids exhibited protein concentrations above 10 %.

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