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# CLIMATIC INPUTS INFLUENCE ON THE YIELDS OF WILD BERRIES HARVESTED FROM TRANSYLVANIAN TESTING SPONTANEOUS FLORA. A CASE STUDY: *RUBUS IDAEUS* L., AND *RIBES NIGRUM* L. IN THE SEASON OF 2022

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***Abstract***

*Even though the influence of the climatic traits on wild berries production and quality is well known, this issue is of interest to be analysed in connection with specific species, areas, and climate. The present study was conducted for characterizing the crude chemical composition, pH, ascorbic acid, and total phenolics and of studied wild berries species, and quantifying the interrelationships among climatic conditions characterizing the fruits collecting area and their dry matter content. In this aim, there were taken into consideration two species of wild berries, Rubus idaeus L. (raspberry), and Ribes nigrum L. (blackcurrants), respectively, harvested from Colibița area, Bistrița-Năsăud County, in the autumn of 2022. The influences of the precipitations, temperature, atmospheric pressure, and wind velocity on studied wild berries dry matter content are quantified. The above-mentioned climatic parameters were collected from databases, and averages were calculated by wild berries vegetation period (March-September 2022). According to the multiregression analysis, and simple correlations calculation, only precipitations and temperature influence the wild berries dry matter content. The studied interrelationships show that increasing trends in temperature and rainfall regimen are moderate and positively correlated with both fresh and dry yields of raspberry, and blackcurrants.*

***Key words****: blackcurrant, multiregression analysis, parameter, raspberry, vegetation period.*

## INTRODUCTION

It is well known that both wild and cultivated berries are a rich source of bioactive secondary metabolites, fibers, vitamins, sugars, phenolics, or polyunsaturated fatty acids.

Numerous studies have shown their significant beneficial effects on human health (Nile and Park, 2014).

Blackcurrants (*Ribes nigrum* L.) native to Northern and Central Europe also North Asia is considered a rich source of nutritional and bioactive compounds.

Literature shows that they represent a very rich source of phenolics (Ovaskainen et al., 2008). The blackcurrants seeds are used as raw material for oil extraction, which is widely used in cosmetics (Lu and Foo, 2003; Matilla et al., 2006).

Raspberries (*Rubus idaeus* L.) is considered native from areas that now are part of the Turkish state, but today is spread worldwide. The fruits are also rich in nutrients and antioxidants as phenolics, which are present in amounts that varies between varieties (Anttonen and Karjalainen, 2005).

The concentration of the bioactive compounds contained in wild berries, including raspberry, and blackcurrants, are known to be influenced by environmental factors (Anttonen and Karjalainen, 2005; Kaldmäe et al., 2013; Remberg et al., 2010).

The present study was conducted for characterizing the crude chemical composition, pH, ascorbic acid, and total phenolics and of studied wild berries species, and quantifying the interrelationships among climatic conditions characterizing the fruits collecting area and their dry matter content. In this aim, there were taken into consideration two species of wild berries, *Rubus idaeus* L. (raspberry), and *Ribes nigrum* L. (blackcurrants), respectively, harvested from Colibița area, Bistrița-Năsăud County, in the autumn of 2022.

## MATERIALS AND METHODS

The raspberry and blackcurrants are the wild berries considered in this study. They were collected from Colibița area, Romania (47°10′14″N 24°53′17″E), in the autumn of 2022. Data concerning the climatic inputs (precipitations, environmental temperature, atmospheric pressure, wind velocity) were collected from specialized databases, (www.meteoblue.ro, https://www.wunderground.com/history /monthly/ro/).

Fruits were conditioned for the chemical analysis in laboratory. The crude chemical composition (water, dry matter, crude protein, crude dietary fibre, crude ash, and nitrogen free compounds) was determined using the Weende scheme (Șara and Odagiu, 2002). For determination of ascorbic acid and total phenolics contents the fruit samples were homogenized with a blender and extracted four times with Ethanol:Water (20:80 v/v) in a 1:3 v/v homogenate:solvent ratio in the dark (15 min each sample).

The total phenolics content was determined by the Folin-Ciocâlteu method as modified by (Singleton et al., 1999). Ascorbic acid was quantified by the Karlsen et al. (2005) methodology, modified by Aaby et al. (2007). Statistical analyses were performed using the software STATISTICA v.12,0 for Windows (StatSoft).

Basic statistics was applied to raw data in order to calculate the means of the crude chemical composition of the fruit's samples, pH, ascorbic acid, and total phenolics.

To calculate the simple correlations between the dry matter content and considered climatic inputs because the linearity of the dependence between variables was not identified, we calculate the correlation using the Spearman non-parametric methodology.

Multiple correlations were calculated between climatic inputs (precipitations and environmental temperature) strong and moderate correlated with fruits dry matter content.

## RESULTS AND DISCUSSIONS

During the wild berries vegetation period the average amount of precipitation was of 2.64 mm, which corresponds to a sum of 592 mm, and average temperature was of 13.89°C. In 2022, during climate parameters monitoring period, the experimental area was characterized by low atmospheric pressure (with an average of 734.57 mm Hg), and wind velocity (with an average of 2.86 m/s). Except atmospheric pressure, high dispersion values are observed for the other climatic parameters. This suggests their high variability which may be explained for temperatures, and precipitations by the succession of three seasons – spring, summer, and beginning of autumn (Table 1).

A mean dry matter of 12.59% is reported for the raspberry fruits collected from Colibița area. Expressed from dry matter the nutrients identified as having the largest mean share are the crude dietary fiber (56.12%), and nitrogen free compounds (27%). The dry matter mean is within the rages observed by Skrede et al. (2012), and Mazur et al. (2014) in cultivated raspberry, but the mean protein content is double, compared to the value reported by Koraqi et al. (2019). For the dietary fiber content we report a higer mean compared to the range (5.20-6.34%) reported by de Souza et al. (2014).

The mean pH recorded the value of 2.81, while for ascorbic acid and total polyphenolics are reported the mean values of 1921.03 mg/100 g dry matter, and 259.09 mg GAE/100 g dry matter. The pH, ascorbic acid, and total polyphenolic means are within the rages observed by Mazur et al. (2014) in ten raspberry cultivated genotypes.

Compared to the pH and total phenolics means reported in 3 wild ecotypes from Turkey by Gülçin et al. (2011) ranging between 3.65 – 3.70, and 91.6-231 mg GAE/100 g dry fruit, the means reportd in our study emphasizes lower value for pH, but much higher for the total phenolics.The crude protein and nitrogen free compounds presented high variability, 29.53%, and 29.70%, respectively (Table 2).

Compared to raspberries, the blackcurrants collected from the same experimental area have a higher mean dry matter content, of 17,36%. The dry matter mean is under the rages (18.90-20.07%) observed by Oancea et al. (2011), in wild blackcurrants harvested from Brașov area, Romania, and by Marjanovic-Balaban et al. (2012) in Serbia (19.54-24.94%).

Table 1. The average evolution of the climatic parameters in Colibița area by March-September 2022

| Issue | n | Mean | Sum | Min. | Max. | Stand.dev. |
|---|---|---|---|---|---|---|
| Precipitations (mm) | 214 | 2.64 | 592.00 | 0.00 | 24.00 | 4.13 |
| Temperature (°C) | 214 | 13.89 | 33191.00 | -1.00 | 26.00 | 6.18 |
| Atmospheric pressure (mm Hg) | 214 | 734.57 | 112389.92 | 718.82 | 751.84 | 5.30 |
| Wind velocity (m/s) | 214 | 2.86 | 436.91 | 0.20 | 15.00 | 2.60 |

Table 2. The crude chemical composition (%), water (%), dry matter (%), pH (pH units), ascorbic acid (mg/100 g fruit) and total phenolics (mg GAE/100 g fruit) in raspbery fruits colected from spontaneous flora of Colibița area, in 2022 season

| Issue | n | X[9] | | Min. | | Max. | | s[10] | | CV%[11] | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | FM[8] | DM | FM | DM | FM | DM | FM | DM | FM | DM |
| Water | 30 | 87.41 | - | 85.00 | - | 90.00 | - | 1.66 | - | 1.89 | - |
| DM[1] | 30 | 12.59 | - | 10.00 | - | 15.00 | - | 1.66 | - | 13.15 | - |
| CP[2] | 30 | 1.42 | 11.26 | 0.90 | 7.15 | 2.10 | 16.68 | 0.42 | 3.33 | 29.53 | 29.53 |
| CF[3] | 30 | 7.07 | 56.12 | 6.10 | 48.45 | 8.00 | 63.54 | 0.54 | 4.32 | 7.70 | 7.70 |
| CA[4] | 30 | 0.71 | 5.62 | 0.59 | 4.69 | 0.81 | 6.43 | 0.07 | 0.59 | 10.52 | 10.52 |
| NFC[5] | 30 | 3.40 | 27.00 | 0.13 | 1.03 | 6.70 | 53.22 | 1.01 | 8.01 | 29.70 | 29.70 |
| pH | 30 | 2.81 | | 2.59 | | 2.95 | | 0.21 | | 7.47 | |
| AA[6] | 30 | 241.91 | 1921.03 | 230.05 | 1827.24 | 249.62 | 1982.68 | 19.39 | 154.01 | 8.01 | 8.01 |
| TP[7] | 30 | 32.62 | 259.09 | 27.55 | 218.82 | 40.26 | 319.78 | 2.95 | 23.43 | 9.04 | 9.04 |

[1]DM - dry matter; CP[2] - crude protein; CC[3] - crude dietary fiber; CA[4] - crude ash; NFC[5] - nitrogen free compounds; AA[6] - ascorbic acid; TP[7] - total phenolics; FM[8] - fresh matter X[9] - mean; s[10] - standard deviation; CV[11] - coefficient of variation.

Compared to raspberries, the blackcurrants collected from the same experimental area have a higher mean dry matter content, of 17.36% (Table 3). The dry matter mean is under the rages (18.90-20.07%) observed by Oancea et al. (2011), in wild blackcurrants harvested from Brașov area, Romania, and by Marjanovic-Balaban et al. (2012) in Serbia (19.54-24.94%). The same, expressed from dry matter, the nitrogen free compounds (82.85%) were identified as having the largest share, while the other nutrients quantified recorded averages between 8.60% crude protein - 3.95% crude crude dietary fiber. pH recorded a mean of 3.02, ascorbic acid a mean of 1445. 27 mg/100 g dry matter, and total phenolics a mean value of 276.09 mg GAE/100 g dry matter. Our study emphasizes protein, ash and ascorbic acid blackcurrants contents within the ranges reported by Marjanovic-Balaban et al. (2012) in Serbia, (1.42-1.65% fresh matter, and 0.68-1.10% fresh matter, 1.9-60.51 mg/100 g fresh fruit, respectively).

Compared to the total phenolics means reported in 4 wild ecotypes from Argentina and Chile by Jiménez-Aspee et al. (2015) ranging between 48-320 mg GAE/100 g fresh fruit, and and 2 ecotypes from Portugal by Spínola et al. (2019) ranging between 87.20.6-103.42 mg GAE/100 g fresh fruit, the mean reportd in our study is lower. The mean pH determined in our study is within ranges 2.92-3.17, reported in 8 cultivars from Canada by Zatylny et al. (2004). Unlike rasperries, for all nutrients low variabilities, under 11% are reported (Table 3).

Table 3. The crude chemical composition (%), water (%), dry matter (%), pH (pH units), ascorbic acid (mg/100 g fruit) and total polyphenolics (mg GAE/100 g fruit) in blackcurrants fruits colected from spontaneous flora of Colibița area, in 2022 season

| Issue | n | X | | Min. | | Max. | | s | | CV% | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | FM[9] | DM | FM | DM | FM | DM | FM | DM | FM | DM |
| Water | 30 | 82.64 | - | 80.80 | - | 84.60 | - | 1.33 | - | 1.61 | - |
| DM[1] | 30 | 17.36 | - | 15.40 | - | 19.20 | - | 1.33 | - | 7.68 | - |
| CP[2] | 30 | 1.49 | 8.60 | 1.39 | 8.01 | 1.60 | 9.22 | 0.07 | 0.43 | 4.99 | 4.99 |
| CC[3] | 30 | 0.69 | 3.95 | 0.59 | 3.40 | 0.80 | 4.61 | 0.07 | 0.42 | 10.74 | 10.74 |
| CA[4] | 30 | 0.80 | 4.60 | 0.70 | 4.03 | 0.90 | 5.18 | 0.06 | 0.35 | 7.70 | 7.70 |
| NFC[5] | 30 | 14.38 | 82.85 | 12.51 | 72.06 | 16.21 | 93.38 | 1.39 | 7.99 | 9.65 | 9.65 |
| pH | 30 | 3.02 | | 2.95 | | 3.14 | | 0.23 | | 7.61 | |
| AA | 30 | 25.09 | 1445.27 | 23.45 | 1350.81 | 27.02 | 1556.45 | 2.23 | 12.84 | 8.89 | 8.89 |
| TP | 30 | 47.93 | 276.09 | 45.00 | 259.21 | 48.00 | 276.49 | 2.26 | 13.01 | 4.71 | 4.71 |

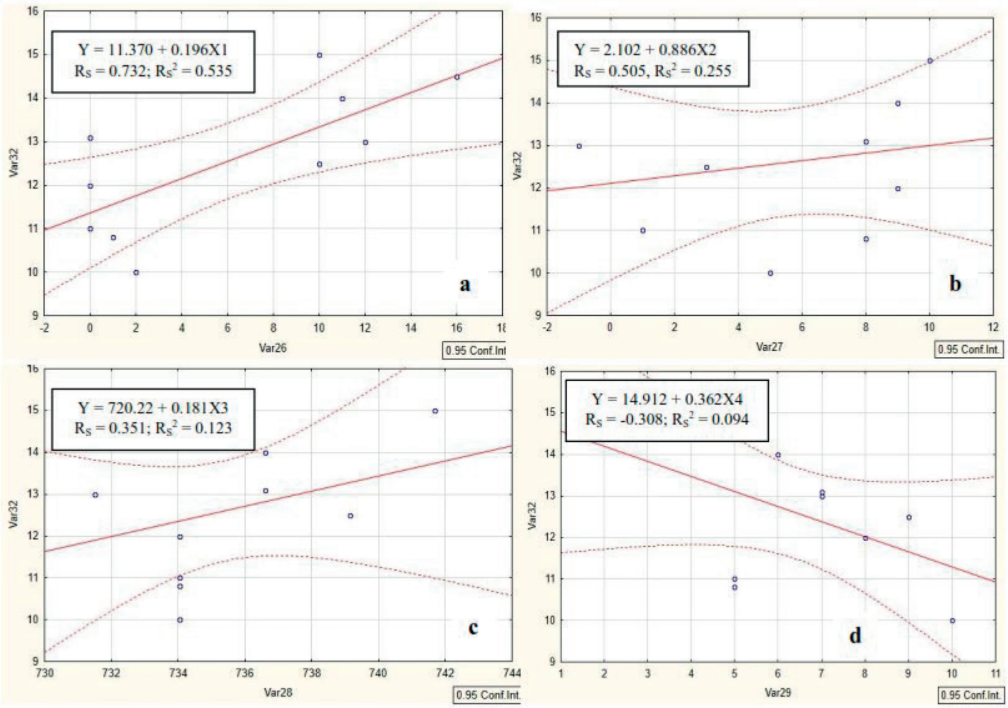
[1]DM - dry matter; CP[2] - crude protein; CC[3] - crude crude dietary fiber; CA[4] - crude ash; NFC[5] - nitrogen free compounds; AA[6] - ascorbic acid; TP[7] - total phenolics; FM[8] - fresh matter X[9] - mean; s[10] - standard deviation; CV[11] - coefficient of variation.

Between raspberries dry matter content and precipitations the strong correlation (R = 0.732) identified shows that in 53.50% of cases the increase of the rainfall regimen is accompanied by the increase of dry matter content in a manner depicted by the regresion line, Y = 11.370 + 0.196X (Figure 1a).

The same evolution is also observed for the correlations between raspberries dry matter content and environmental temperature, or atmospheric pressure, mentioning that if concerning the environmental temperature it has a mean intensity (R = 0.505), while with atmospheric pressure, according to the value of the correlation coefficient (R = 0.351) is may be framed as weak (Figure 1b, and Figure 1c).

Mazur et al. (2014) found positive correlations between a raspberry cultivar fruits weight at harvesting and a week before harvesting, and environmental temperature, ranging between R = 0.460-0.530. Studies performed in Norway by, published in 2014 and 2016, emphasized positive correlations ranging between R = 0.380-0.800, between dry matter of five blackcurrants cultivars, and environmental temperature, while between above mentioned cultivars and precipitations, unlike our findings, the results are controversial, meaning that in the study published in 2016 they were negative, ranging between R = 0.090-0.640, while in the study published in 2015 they were both positive and negative, function of cultivar.

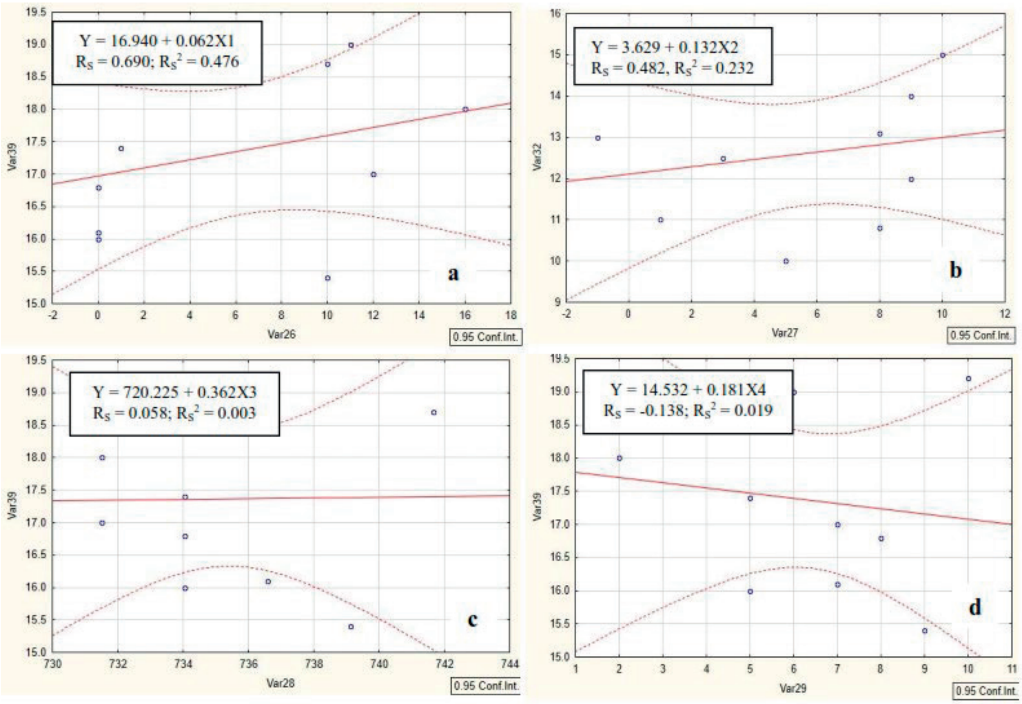
A negative weak correlation (R = -0.308) is reported between raspberries from spontaneous flora dry matter content and wind velocity and this shows that in only 9.40% of cases the increase of the wind velocity corresponds to the increase of dry matter content in a manner, which is suggested by the regresion line, tha also shows by the 0,094 coefficient the low contribution of the wind velocity Y = 14,912 + 0.094X (Figure 1d).




Var 26 - precipitations (mm); Var 27 - precipitations (°C); Var 28 - atmospheric pressure (mmHg); Var 29 - wind velocity (m/s); Var 32 – raspberries dry matter production (g); Y - raspberries dry matter production; X1 - precipitations; X2 - temperature; X3 - atmospheric pressure; X4 - wind velocity; $R_s$ - coefficient of correlation Spearman; $R_S^2$ - coefficient of determination.

Figure 1. The simple correlation between the climatic factors precipitations (a), temperature (b), atmospheric pressure (c), wind velocity (d), and raspberry dry matter

Concerning blackcurrants, also strong correlation (R = 0,690) is identified between dry matter content and precipitations, and this emphasizes that in 47.60% of cases the increase of the rainfall regimen is accompanied by the increase of dry matter content in a manner depicted by the regresion line, Y = 16.940 + 0.062X (Figure 2a). Studies performed in Norway by Woznicki et al., published in 2015 and 2016, emphasized positive correlations ranging between R = 0.380-0.800, between dry matter of five blackcurrants cultivars, and environmental temperature, while between above mentioned cultivars and precipitations, unlike our findings, the results are controversial, meaning that in the study published in 2016 they were negative, ranging between R = 0.090-0.640, while in the study published in 2015 they were both positive and negative, function of cultivar. With the environmental temperature a mean intensity (R = 0.482) is reported, while with atmospheric pressure (R = 0.058) it is very weak (Figure 2b, and Figure 2c). A negative weak correlation (R = -0.132) is reported between blackcurrants dry matter content and wind velocity and this shows that in only 1.90% of cases the increase of the wind velocity corresponds to the increase of dry matter content in a manner depicted by the regresion line, Y = 14,532 + 0.181X (Figure 2d).

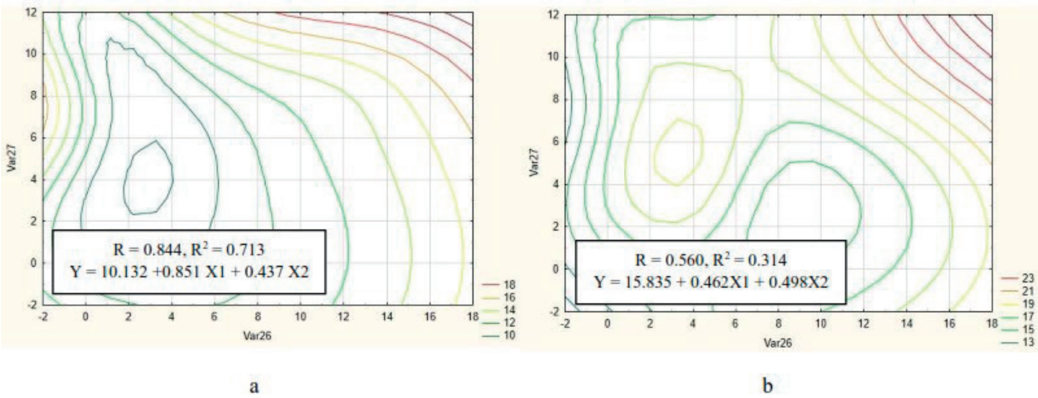



Var 26 - precipitations (mm); Var 27 - precipitations (°C); Var 28 - atmospheric pressure (mmHg); Var 29 - wind velocity (m/s); Var 36 – blackcurrants dry matter production (g); Y – blackcurrants dry matter production; X1 – precipitations; X2 – temperature; X3 - atmospheric pressure; X4 - wind velocity; $R_s$ – coefficient of correlation Spearman; $R_S^2$ – coefficient of determination.

Figure 2. The simple correlation between the climatic factors precipitations (a), temperature (b), atmospheric pressure (c), wind velocity (d), and blackcurrants dry matter

According to the values obtained for the simple correlations, only rainfall regimen and temperature affect the wild berries yields.

The studied interrelationships between plants and climatic factors show that increasing trends in temperature and rainfall regimen are positively strong correlated (R = 0.844) with raspberry dry matter production, and positively moderate correlated (R = 0.560) with blackcurrants dry matter production (Figure 3).




Var 26 - precipitations (mm); Var 27 - temperatures (°C); a - raspberry dry matter production (g); b – blackcurrants dry matter production 9g); X1 - precipitations; X2 – temperature; R - coefficient of multiple correlation; $R^2$ - coefficient of determination.

Figure 3. The multiple correlation between the climatic factors precipitations, temperature, and dry matter of raspberry (a) and blackcurrants (b) fruits colected from spontaneous flora of Colibița area, in 2022 season

The study of the multiregression line, in raspberry (Y = 10.132 + 0.852X1 + 0.437X2), shows that the precipitations positively influence in a higher measure the evolution of the dry matter content (Figure 3a), while in blackcurrants (Y = 15.835 + 0.462X1 + 0.498X2) both precipitation and environmental temperature positively influence, in about the same extent, the dry matter content (Figure 3b).

## CONCLUSIONS

This study shows that both studied species raspberries, and blackcurrants, respectively have a high content in water of 87.71%, and 82.64%, respectively. In raspberry the highest share of nutrients expressed from dry matter are the crude dietary fiber (56.12%), and nitrogen free compounds (27%), and in blackcurrats nitrogen free compounds (82.85%) and crude protein (8.60%. in influence of the precipitations, temperature, atmospheric pressure, and wind velocity on studied wild berries fresh and dry yields are quantified. The above-mentioned climatic parameters were recorded daily, and monthly averages were calculated during wild berries vegetation period. Both species contain large amounts of total phenolics According to the multiregression analysis, and simple correlations calculation, only rainfall regimen and temperature affect the wild berries dry matter content, of 259.09 mg GAE/100 g raspberry dry matter, and 276.09 mg GAE/ 100 g blackcurrants dry matter. The studied interrelationships show that increasing trends in temperature and rainfall regimen are moderate and positively correlated with dry yields of raspberry, and blackcurrants. These results show that weather conditions represented by precipitations and environmental temperature have a positive contribution to the dry matter content of raspberry and blackcurrant species from the spontaneous flora, within the specific climate of Colibița area, Romania.

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