

THE QUALITY OF FODDER BEET IN THE REPUBLIC OF MOLDOVA

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Abstract. The results of the evaluation of the biochemical composition and nutritive energy value of local cultivars of fodder beet – *Beta vulgaris*: 'Ciugur' and 'Ruja', created at the “Selectia” Research Institute of Field Crops Bălți and cultivated in the experimental plot of the “Alexandru Ciubotaru” National Botanical Garden (Institute) MSU, Chisinau, Republic of Moldova, are presented in this article. It was established that fodder beet roots from the studied cultivars contained 104.5-152.5g/kg DM, and its biochemical composition was: 6.37-8.67% CP, 0.37-0.77 % EE, 9.91-12.08% CF, 69.64-76.78% NFE, 48.05-49.62 % soluble sugars, 5.01-5.10 % starch, 6.57-8.84% ash, 1.5-1.6 g/kg Ca, 1.7 g/kg P with nutritive energy value 16.99-17.10 MJ/kg GE, 11.47-11.98 MJ/kg ME and 7.23-7.60 MJ/kg NEL.

Keywords: *Beta vulgaris*, biochemical composition, cv. 'Ciugur', cv. 'Ruja', fodder beet roots, nutritive energy value

In modern animal husbandry, forage crops have an undeniable role in providing nutrients and meeting the energy requirements of farm animals. Feeding the livestock high quality forage can be very useful and effective for their breeding, reproduction, meat, dairy, leather and wool. Livestock production relied on a large diversity of fodder crops to sustain animals year-round, including root crops.

The genus *Beta*, subfamily *Betoideae*, family *Amaranthaceae* (formerly *Chenopodiaceae*) consists of 9 accepted species of annual, biennial and perennial plants, often with fleshy, thickened roots. The best known member is the common

beet, *Beta vulgaris*. About 2500 years ago, the first beets were domesticated. Historically, beets have been used as both food for people and fodder for animals. The first recorded use of beets is from the Middle East. The development of cultivated beets is characterized by breeding to obtain the desired characteristics for various applications, and for a wide variety of shapes and colours, especially in the root swollen parts. The classification of both wild and cultivated forms of *Beta vulgaris* is confusing. It is generally accepted that all cultivated beets belong to the *Beta vulgaris* subsp. *vulgaris*. Currently, *Beta vulgaris* subsp. *vulgaris* has an immense economic

importance as sugar crop (*Beta vulgaris* subsp. *vulgaris*, var. *altissima*), and a great importance as a vegetable crop (*Beta vulgaris* subsp. *vulgaris*, var. *flavescens* and *Beta vulgaris* subsp. *vulgaris*, var. *cicla*), and as fodder crop (*Beta vulgaris* subsp. *vulgaris*, var. *crassa*). This species is also used as medicinal plant, ornamental plant, dye and as renewable energy resource (LANGE et al. 1999; MIRAJ, 2016; AL JBAWI, 2020; KUMAR et al. 2022).

Fodder beet, *Beta vulgaris* subsp. *vulgaris*, var. *crassa*, syn. *Beta vulgaris* ssp. *vulgaris* var. *alba*; *Beta vulgaris* ssp. *vulgaris* var. *rapacea* is a biennial plant. In the first year of growth, the vegetative part develops. The dark green, heart-shaped leaves are borne in a rosette, lying horizontally to catch as much light as possible. In the underground part, the fleshy and swollen root system develops intensively. In the second year, if the root is not harvested and after exposure to cold, the rosette turns into a 50-120 cm tall, erect, branched, ribbed, striate flower stalk, bears small, green, bisexual flowers without petals. The ovary forms a fruit which is embedded in the base of the perianth of the flower. Fruits with monogerm seeds are formed when a flower occurs singly, multigerm seeds are formed by an aggregation of 2 or more flowers.

Fodder beet cultivars occur in different root shapes (flat globe,

globe, spindle, cylinder) and colours (yellow, orange, red, white and purple). Fodder beet crops are cultivated as annual crops and the roots must be harvested before winter since they do not withstand frost.

Fodder beets are considered more drought-tolerant than other root crops, and less sensitive to weather variations than turnips and rutabagas. This crop is associated with favourable agronomic characteristics such as tolerance to salinity and drought, less water requirement and proper nutritional characteristics such as production of forage and silage with high nutritional value, good taste and good resistance to environmental changes. The fodder beet root and leaves contain valuable nutrients, pigments and vitamins, hydrocarbons, mineral salts and organic acids. The yields and chemical composition of fodder beet varies between cultivars, growing conditions, and among shoots and roots of the plant. Its inclusion in the diet of animals improves their balanced nutrition and it is eagerly eaten by cattle, pigs, rabbits, goats, sheep and horses. Usually, the fodder beet root is given to animals chopped and mixed with hays or straws (HEUZÉ et al., 2020).

The fodder beet is researched in various universities and research centres, creating new cultivars, elaborating technological elements of cultivation, harvesting and preservation, developing techniques

of including it in the diet of different species and breeds of animals (CLARK et al., 1987; AVARVAREI, 1999; NAESCU, 2001; ZAMFIR et al. 2001; MOISUC et al., 2010; TURK, 2010; COJOCARIU et al., 2011; MATTHEW et al. 2011; ADIE et al., 2018; MIHAI, 2018; ENCHEV & BOZHANSKA, 2022, 2024). Fodder beet is currently cultivated in almost all European countries, Asia, Africa, America, New Zealand and Australia. In the Catalogue of Plant Varieties of the Republic of Moldova, there are 3 registered cultivars of fodder beet *Beta vulgaris*, including, two local cultivars 'Ciugur' and 'Ruja', created at the "Selectia" Research Institute of Field Crops Bălți. The cultivar 'Ciugur' is multigerm, polyploid, the root shape is cylindrical-conic with greenish-white colours, the potential yield 200–210 t/ha roots and 38–40 t/ha leaves. The cultivar 'Ruja' is multigerm, polyploid, resistant to cercospora, mildew and fusarium rot; the potential yield 150–170 t/ha roots and 33–35 t/ha leaves (BOINCEN et al. 2020).

The goal of the current study was to evaluate the biochemical composition and nutritive energy value of fodder beet root from local cultivars 'Ciugur' and 'Ruja'.

MATERIALS AND METHODS

The local cultivars of fodder beet *Beta vulgaris*: 'Ciugur' and 'Ruja', created at the "Selectia" Research

Institute of Field Crops Bălți and cultivated in the experimental plot of the "Alexandru Ciubotaru" National Botanical Garden (Institute) MSU, Chisinau, Republic of Moldova served as subjects of the research. The samples of fodder beet roots were collected at the end of September. The dry matter content was detected by drying samples up to constant weight at 105°C. The manually chopped fodder beet roots to 1.5-2.0 cm were dehydrated in an oven with forced ventilation at a temperature of 60°C; at the end of the fixation, the biological material was finely ground in a laboratory ball mill. The evaluation of fodder quality: crude protein (CP), crude fat (EE), crude cellulose (CF), nitrogen-free extract (NFE), soluble sugars (SS), starch, ash, calcium (Ca), phosphorus (P) were carried out in the Laboratory of Nutrition and Forage Technology of the Scientific-Practical Institute of Biotechnology in Animal Husbandry and Veterinary Medicine, in accordance with the methodological indications. The gross energy (GE), metabolizable energy (ME), net energy for lactation (NEL) were calculated according to standard procedures.

RESULTS AND DISCUSSION

We found that the dry matter content in fodder beet root mass of the studied cultivars varied from 104.5 g/kg in cv. 'Ciugur' to 152.5 g/kg in cv. 'Ruja'. The biochemical

composition and nutritive energy value of studied fodder beet cultivars are presented in Table 1. We would like to mention that the concentration of nutrients in fodder beet root dry matter was 6.37-8.67% CP, 0.37-0.77 % EE, 9.91-12.08% CF, 69.64-76.78% NFE, 48.05-49.62 % soluble sugars, 5.01-5.10 % starch, 6.57-8.84% ash, 1.5-1.6 g/kg Ca, 1.7 g/kg P with nutritive energy value 16.99-17.10 MJ/kg GE, 11.47-11.98 MJ/kg ME and 7.23-7.60 MJ/kg NEL. The root dry matter of cv. 'Ciugur' was characterised by

optimal amounts of crude protein, crude fats, crude cellulose, ash and calcium. The root dry matter of cv. 'Ruja' contained higher concentration of nitrogen free extract, soluble sugars and low concentration of crude celluloses, which had a positive impact on energy concentrations, but where was also a lower amount of crude protein, crude fats, ash. It has been determined that fodder beet root dry matter of the studied cultivars does not differ significantly in the starch and phosphorus content.

Table 1.

The biochemical composition and nutritional energy value of fodder beet root cultivars

Indices		Cultivars	
		'Ciugur'	'Ruja'
Dry matter, % root fresh mass		10.45	15.25
Crude protein, g/kg	dry matter	86.7	63.7
	fresh mass	9.1	9.7
Crude fats, g/kg	dry matter	7.7	3.7
	fresh mass	0.8	0.6
Crude cellulose, g/kg	dry matter	120.8	99.1
	fresh mass	12.6	15.1
Nitrogen free extract , g/kg	dry matter	696.4	767.8
	fresh mass	72.8	117.1
Soluble sugars, g/kg	dry matter	480.5	496.2
	fresh mass	50.2	75.7
Starch, g/kg	dry matter	50.5	50.1
	fresh mass	5.3	7.6
Ash, g/kg	dry matter	88.4	65.7
	fresh mass	9.2	10.0
Calcium, g/kg	dry matter	1.6	1.5
	fresh mass	0.2	0.2
Phosphorus, g/kg	dry matter	1.7	1.7
	fresh mass	0.2	0.3
Digestible energy, MJ/ kg	dry matter	16.99	17.10
	fresh mass	1.78	2.61
Metabolizable energy, MJ/ kg	dry matter	11.47	11.98
	fresh mass	1.20	1.83
Net energy for lactation, MJ/ kg	dry matter	7.23	7.60
	fresh mass	0.76	1.16

Different results regarding the nutrient content and energy value of root mass from *Beta vulgaris* are given in the specialized literature. According to CLARK et al. (1987) the fodder beet root contained 159-214 g/kg DM, 6.2 % CP, 12.7 % NDF, 64.9% WSC, 16.0 MJ/kg GE, 14.0 MJ/kg DE and 11.8 MJ/kg ME. TURK (2010) mentioned that fodder beet cv. Ecdogelb contained 117.7-121 g/kg DM, 8.32-8.83 % CP, 14.07-14.96% ADF 19.49-20.73% NDF. MATTHEW et al. (2011) revealed that the nutritional profile of fodder beet root was as follows: 6.2-10.7 % CP, 9.4-11.6% NDF, 59.6-62.8 % SS, 14.2-14.7 MJ/kg ME, but fodder beet leaf, respectively, 22.2-25.3 % CP, 26.9-27.2% NDF, 8.8-11.6 % SS, 10.4-11.2 MJ/kg ME. SINGH & GARG (2012) compared the dry matter content and the biochemical composition of the roots of sugar beet and fodder beet and found that fodder beet cultivars contained 100-140 g/kg DM, 5.7-10.9 % CP, 0.5-1.1 % EE, 3.6-6.6% CF, 1 g/kg Ca, 1-2 g/kg P, but sugar beet cultivars had 110-180 g/kg DM, 4.3-8.4 % CP, 0.5-0.8 % EE, 3.6-6.6% CF, 1-2 g/kg Ca, 1-2 g/kg P. EDWARDS et al. (2014) mentioned that fodder beet roots contained 150-181 g/kg DM, 10.4-10.8 % CP, 20.5-20.6 % NDF, 56.4-57.0 % WSC, 12.1-12.2 MJ/kg ME. SAKR et al. (1914) revealed that fodder beet roots contained 8.5 % CP, 8.1% CF, 4.4% DCP and 81% TDN. SORATHIYA et al. (2015) mentioned that the composition of

sugar beet tubers was 5.20% CP, 1.60 % EE, 12.30% CF, 78.80% NFE and 6.10% ash. HEUZÉ et al. (2020) reported that fodder beet roots contained 79-214 g/kg dry matter with 4.6-14.6% CP, 4.3-11.6% CF, 10.2-27.2% NDF, 5.4-17.0% ADF, 0.1-2.8% EE, 0.8-1.0% lignin, 54.7-81.9% SS, 3.5-32.7 % ash, 0.8-14 g/kg Ca, 1-5 g/kg P, 89.8% OMD, 15.6-16.6 MJ/kg GE, 11.5MJ/kg ME for ruminants. DALLEY et al. (2017) found that fodder beet root contained 7.9 % CP, 6.7% ADF, 11.7% NDF, 72.5 % soluble sugars and starch, but fodder beet whole plant – 7.6 % CP, 19.0% ADF 30.9% NDF, 48.6 % soluble sugars and starch, respectively. ADIE et al. (2018) reported that the nutritive value of the fodder beet roots was: 6-10% CP, 70-80% digestible and 12-13 MJ/kg ME. FLEMING et al. (2018) revealed that the quality indices of the fodder beet root were 203 g/kg DM with 94.7 % OM, 8.5 % CP, 6.7% ADF 14.2% NDF, 54.9% WSC. SALAMA & ZEID (2017) mentioned that fodder beet root contained 108-110 g/kg DM with 24.1 % NDF, 12% ADF and 2.65 % ADL. AL JBAWI et al. (2018) reported that, depending on the organic and potassium fertilizers applied, the fodder beet root contained 110-131 g/kg DM with 13.01-14.66 % CP, but fodder beet shoot contained 114-131 g/kg DM with 7.50-8.37 % CP. DALLEY et al. (2020) mentioned that the quality indices of the fodder beet root were 187 g/kg DM with 95.2 %OM, 9.1 %

CP, 5.6% ADF, 9.3% NDF, 65.7% SS, 91.7% DOM, 14.7MJ/kg ME, 0.11% P, 0.14% Ca. MOFEEDA et al. (2020) found that the forage quality of fodder beet root was 6.35-7.04 % CP, 2.38-3.06% DCP, 7.67-7.87% CF, 68.68-69.32% carbohydrates, 85.60-85.63% TDN. KUMAR et al. (2022) found that the dry matter, the biochemical composition and nutritive value of the fodder beet roots were 161 g/kg DM, 4-10 % CF, 5-10 % CP, 9.5% ADF, 16% NDF, 55.7% TS, 16.2MJ/kg GE, 13.2 MJ/kg ME. SAYED et al. (2023) mentioned that the main quality indices of fodder beet were 5.85-10.89 % CP, 7.78-12.51 % CF, 62.85-68.38 % carbohydrates. WHEADON et al. (2023) reported that the whole plant of fodder beet contained 140-166 g/kg DM, 10.4-13.2 % CP, 13.8-16.8 % NDF, 44.0-55.7 % soluble sugars, 2.7-3.3 g/kg Ca, 1.3-2.1 g/kg P and 12.5-14.1 MJ/kg ME. WOODS et al. (2023) mentioned that fodder beet contained 12.9 % CP, 23.9 % NDF, 40.6 % SS, 12.2-12.9 MJ/kg ME, 0.21 % P, 0.38 % Ca. ENCHEV & BOZHANSKA (2022, 2024) reported that the chemical composition and the nutritional value of root dry matter of fodder beet was: 13.99-15.64 % CP, 0.53-0.91 % EE, 6.65-9.19% CF, 66.48-

68.31% NFE, 8.92-9.42% ash, 7.0-12.8 g/kg Ca, 1.8-2.1 g/kg P, 16.48-16.50MJ/kg GE, 11.45-11.60 MJ/kg ME, 1.17-1.19 feed units for milk (FUM) and 1.27-1.29 feed units for growth (FUG), but – of sugar beet root – 9.11-9.58 % CP, 0.24-0.35 % EE, 4.77-6.88% CF, 77.66-81.88% NFE, 3.54-6.00% ash, 8.70-8.75 g/kg Ca, 1.13-1.40 g/kg P, 16.51-16.86 MJ/kg GE, 12.59-13.14 MJ/kg ME, 1.32-1.38 FUM/kg and 1.48-1.57 FUG/kg, respectively.

CONCLUSIONS

1. The studied local fodder beet cultivars '*Ciugur*' and '*Ruja*' contain a lot of nutrients, which make them suitable to be used as a part of diverse livestock diets.
2. The root dry matter of cv. '*Ciugur*' was characterised by optimal amounts of crude protein, crude fats, crude cellulose, ash, calcium. The root dry matter of cv. '*Ruja*' had higher concentration of nitrogen free extract, soluble sugars and low concentration of crude celluloses.
3. It is necessary to continue the research on the quality indices of fodder beet root, the impact of delayed harvest time and conditions of storage during the winter-spring season.

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