# THE QUALITY OF FODDER FROM SOME WINTER CEREALS CROPS GROWN UNDER THE CONDITIONS OF THE REPUBLIC OF MOLDOVA

**ŢÎŢEI Victor**

[1] *"Alexandru Ciubotaru" National Botanical Garden (Institute), Republic of Moldova, MD 2002 Chisinau, 18 Pădurii str.*

*Corresponding author's email: vic.titei@ gmail.com*

**Abstract.** *The results of the evaluation of the biochemical composition and nutritive value of fresh mass from winter cereals crops: barley Hordeum vulgare 'Excelent', wheat Triticum aestivium 'Moldova 614', triticale Trticosecale 'Ingen 40' and rye Secale cereale 'Zîmbreni 70' cultivated in the experimental plot of the "Alexandru Ciubotaru" National Botanical Garden (Institute), Chisinau, Republic of Moldova, are presented in this article. It was established the concentration of nutrients in dry matter from whole-plant of studied winter cereals crops was 8.38-12.69% CP, 2.78-3.17 % EE, 32.11-40.00% CF, 38.20-43.59% NFE, 7.14-9.34% ash, 2.3-3.3 g/kg Ca, 2.1-2.9 g/kg P with energy value 18.15-18.35 MJ/kg GE, 8.14-8.92 MJ/kg ME, 4.38-4.96 MJ/kg NEl. The quality of the prepared silage from Hordeum vulgare 'Excelent' and Triticum aestivium 'Moldova 614' was: pH= 4.04-4.08, 25.9-31.4 g/kg lactic acid, 0-g/kg butyric acid, 4.4-7.0 g/kg acetic acid, 214.4-229/kg DM with 11.08-12.67% CP, 3.62-3.93% EE, 31.39-37.99% CF, 41.53-43.63% NFE, 0.69-0.90 % sugar, 0.67-0.77 % starch, 8.68-9.28% ash, 41.50-57.17 mg/kg carotene, 18.43-19.07 MJ/kg GE, 8.43-8.77 MJ/kg ME, 4.54-5.09 MJ/kg NEl.*

***Keywords****: biochemical composition, fresh mass, Hordeum vulgare 'Excelent', Secale cereale 'Zîmbreni 70', silage, Trticosecale 'Ingen 40', Triticum aestivium 'Moldova 614'*

## INTRODUCTION

Climate change, from a more general point of view, affects crop production, animal production, negatively affecting food security and the rate of economic development.

Livestock constituted one of the main economic activities and plays an important role in the agricultural economy and food security of the Republic of Moldova. The economic feasibility of livestock husbandry is dependent on the valorification of animals genetic potential, good health care, balanced feeding, diversification of animal products and its efficient marketing (COŞMAN et al. 2018, 2021; MAŞNER et al. 2021).

It is a known fact that the nutritional value of forages is dependent largely on seasonal temperature, light and rainfall trends, soil type, energy inputs applied over the growing cycle and, to a lesser extent, to the cultivar within the species. The adverse climatic conditions, water deficiency in soil, associated to drought, high temperatures and strong evapotranspiration, from the years 2007, 2012, 2015, 2020, 2022 which had serious consequences on the

development of agriculture, in particularly reduction forage production and the drastic decrease of number of livestock. In Republic of Moldova the surfaces sown with perennial forage crops are very small, grassland have low productivity. Corn *Zea mays* is one of the most common annual forage crop, but frequent droughts, rising prices of seeds, agricultural equipment, fuel and fertilizers have a negative impact on the productivity and the cost of forage. Winter cereals, to overcome these obstacles, supply an important alternative. Harvesting winter cereals crops for forage has several advantages: arable land might be double cropped with successive crops; the risk of crop loss from rain, wind or hail is decreased; circumstances sometimes make it desirable, even, necessary, to use these crops for forage even though they were planted for another purpose, e.g., weather stressed (drought and heat, hail) and biotic factors (massive attack of insects and pests) wheat, barley, rye and triticale with a low level of grain production might be more profitable if harvested whole-plant as natural forage and silage production.

The objective of this study was to evaluate the chemical composition and nutritive value of forages from whole plant of winter cereals crops: barley *Hordeum vulgare*, wheat *Triticum aestivium*, triticale *Trticosecale* and rye *Secale cereale* grown under the conditions of the Republic of Moldova.

## MATERIALS AND METHODS

The local cultivars of winter cereals barley *Hordeum vulgare* 'Excelent', wheat *Triticum aestivium* 'Moldova 614', triticale *Trticosecale* 'Ingen 40' and rye *Secale cereale* 'Zîmbreni 70' created at the Research Institute for Field Crops "Selectia" and Institute of Genetics, Physiology and Plant Protection and cultivated in the experimental plot of the National Botanical Garden (Institute) "Alexandru Ciubotaru", Chişinău, latitude 46°58′25.7″N and longitude N28°52′57.8″E, served as subjects of the research.

The plant samples were collected in pre-flowering stage. The harvested plants were chopped into 1.5-2.0 cm small pieces, with a laboratory forage chopper, the dry matter content was detected by drying samples up to constant weight at 105°C. The silage was prepared from chopped green mass, compressed in well-sealed glass containers, stored at ambient temperature (18-20°C). After 45 days, the containers were opened, and the sensorial and fermentation indices of the conserved forage were determined in accordance with standard laboratory procedures – the Moldavian standard SM 108*. The fresh mass and fermented fodder samples 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), carotene, silage pH index, concentration of organic acids (lactic, acetic and butyric) in free and fixed state 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

The bio-morphological characteristics of the whole plant have a significant impact on the biochemical composition and feed value. Due to the favourable weather conditions recorded in the spring of 2021, characterized by optimal humidity and temperatures, it was found that at the harvest time, in the pre-flowering stage, the studied annual fodder cereals reached 99 cm in height – *Hordeum vulgare*, 95 cm – *Triticum aestivium*, 114 cm – *Triticale* and 173 cm – *Secale cereale*. It was found that the harvested plants of *Triticum aestivium* contained 19.8% leaves, 19.2% spikes and 61 % stems; *Secale cereale* – 19.0% leaves, 13.6% spikes and 67.4 % stems; *Triticale* – 19.3% leaves, 17.6% spikes and 63.1 % stems; *Hordeum vulgare* – 33.0% leaves, 12.8% spikes and 54.2 % stems. The dry matter content (D.M.) in the fresh biomass was 18.63% in *Hordeum vulgare*, 21.23% in *Triticale*, 22.58% in *Triticum aestivium*, 29.90% in *Secale cereale* and 30.12% in *Hordeum vulgare*.

During the research carried out in USA, it was found that, in the heading-milk stage of grain fill, the barley fresh mass contained 15.0-23.8 % leaves, 55.7-61.9 % stems and 14.3-29.3 % spikes; rye fresh mass contained 7.1-17.7 % leaves, 70.5-71.6 % stems and 10.7-22.4 % spikes; the wheat forage contained 14.2-23.5 % leaves, 55.9-58.7 % stems and 17.8-29.9 % spikes (BECK & JENNINGS, 2014). In Canada, the natural fodder of triticale contained 24.0 % leaves, 35.0 % stems and 40.8 % spikes, but harvested barley plants – 27.1% leaves, 24.1 % stems and 48.9 % spikes (KHORASANI et al, 1997).

Analysing the results of the biochemical composition of dry matter from whole-plant of studied winter cereals crops, Table 1, we would like to mention that the concentration of nutrients was 8.38-12.69% CP, 2.78-3.17 % EE, 32.11-40.00% CF, 38.20-43.59% NFE, 7.14-9.34% ash, 2.3-3.3 g/kg Ca, 2.1-2.9 g/kg P with energy value 18.15-18.35 MJ/kg GE, 8.14-8.92 MJ/kg ME, 4.38-4.96 MJ/kg NEl. The fresh fodder from *Hordeum vulgare* 'Excelent' was characterised by higher content of crude protein, nitrogen free extract and calcium, optimal crude fats and ash, but low content of crude cellulose. The fodder from *Triticum aestivium* 'Moldova 614' had optimal concentration of crude protein, crude cellulose, nitrogen free extract, phosphorus and low amounts of crude fats and calcium. The fodder from *Triticale* 'Ingen 40' contained higher amounts of crude fats, crude cellulose, ash and

phosphorus, but lower amounts of crude protein and nitrogen free extract. The fresh fodder from *Secale cereale* 'Zîmbreni 70' was characterised by lower content of crude protein, crude fats, ash and phosphorus, but very high content of nitrogen free extract. The gross energy concentrations in fresh fodder from studied cultivars of winter cereals do not differ significantly, 18.15-18.35 MJ/kg, but metabolizable energy varies from 8.14 MJ/kg to 8.92 MJ/kg and net energy for lactation – from 4.38 MJ/kg to 4.96 MJ/kg. The fodder from *Hordeum vulgare* 'Excelent' was characterised by higher energy concentrations.

Different results regarding the biochemical composition and the nutritive value of the harvested mass from winter cereals are given in the specialized literature. According to KHORASANI et al. (1998) the harvested barley plant contained 451 g/kg DM, 91.6% OM, 11.7 % CP, 26.7 % ADF, 49.9% NDF, 3.25 % ADL and triticale plant 344 g/kg DM, 92.5% OM, 12.3 % CP, 30.3 % ADF, 54.4% NDF, 4.45 % ADL, respectively. HEIERMANN et al. (2009) revealed that the harvested whole plants of cereals in milk stage had a different nutrient content, thus barley fresh mass contained 274 g/kg DM, 93.2% OM, 13.1 % CP, 21.4 % CF, 2.2% EE, 9.4 % sugar, 16.3 % starch; rye fresh mass - 293 g/kg DM, 93.5% OM, 12.3 % CP, 29.3 % CF, 2.1% EE, 8.8 % sugar, 9.1 % starch; triticale fresh mass - 337 g/kg DM, 95.0% OM, 9.3 % CP, 24.0 % CF, 1.4% EE, 11.5 % sugar, 7.4 % starch. KOCER&ALBAYRAK (2012) found that the barley biomass harvested in June contained 10.46% CP, 57.37% NDF, 31.84% ADF, 60.24% TDN and RFV=103.93. ASKEL et al. (2017) found that the dry matter content and biochemical composition of barley forage was 247.8 g/kg DM, 8.87 % CP, 39.20 % ADF, 70.56% NDF, 4.66% ash; wheat forage - 267.8 g/kg DM, 9.46 % CP, 41.42 % ADF, 70.06% NDF, 4.31% ash; rye forage - 323.8 g/kg DM, 8.48 % CP, 43.90 % ADF, 69.57% NDF, 4.72% ash; triticale forage -194.3 g/kg DM, 11.37 % CP, 38.09 % ADF, 65.79% NDF, 5.22% ash. In our previous research it was established that biochemical composition and nutritive value of triticale herbage harvested in wax grain stage was: 4.7% CP, 41.3% CP, 42.8% ADF, 71.2% NDF, 4.8% ADL, 29.0% TSS, 37.4% Cel, 29.0% HC, 4.6%ash, 515 g/kg DDM, 455 g/kg OMD, 511 g/kg TDN, RFV=73; wheat forage 6.5 % CP, 37.4 % CP, 39.0% ADF, 64.0% NDF, 5.3% ADL, 20.5% TSS, 33.1% Cel, 25.0% HC, 4.7%ash, 532 g/kg DDM, 487 g/kg OMD, 560 g/kg TDN, RFV=85; rye forage- 4.4 % CP, 42.2 % CP, 43.1% ADF, 70.0% NDF, 5.3% ADL, 26.9% TSS, 37.8% Cel, 26.9% HC, 4.2%ash, 458 g/kg DDM, 415 g/kg OMD, 507 g/kg TDN, RFV=65. KAHRARYAN et al. (2021) revealed that the forage quality of barley harvested in milk stage was 17.56% CP, 58.42% NDF, 52.23% ADF, 19.31% WSC and 47.75% DMD. The silage is an important agricultural technique for maintaining and increasing the productivity of herds, especially during the off-season, when there is scarcity of food for husbandry herbivorous animals, its

preparation being an excellent strategy in reducing feed costs and increasing profitability.

When opening the glass vessels with ensiled material, prepared from *Hordeum vulgare* 'Excelent' and *Triticum aestivium* 'Moldova 614', there was gas leakage but no liquid leakage from the conserved mass. The silages have agreeable colour and aroma, the consistency was retained in comparison with the initial green mass, without mould and mucus. During the sensorial assessment, it was found that, in terms of colour, the silages from barley and wheat plants have homogeneous olive colour with pleasant smell, specific to pickled vegetables. The fermentation quality and nutrient content of prepared silages are shown in Table 2. It has been determined that the pH index was 4.04-4.08, the concentrations of organic acids varied from 30.3g/kg in *Triticum aestivium* 'Moldova 614' to 38.4g/kg *Hordeum vulgare* 'Excelent' and most amounts of organic acids were in fixed form.

The lactic acid constituted 81.8-85.5 % of total organic acids. The butyric acid not was detected. The concentration of nutrients and energy in prepared silages was 11.08-12.67% CP, 3.62-3.93% EE, 31.39-37.99% CF, 41.53-43.63% NFE, 0.69-0.90 % sugar, 0.67-0.77 % starch, 8.68-9.28% ash, 41.50-57.17 mg/kg carotene, 18.43-19.07 MJ/kg GE, 8.43-8.77 MJ/kg ME, 4.54-5.09 MJ/kg NEl. It was found that during the process of ensiling, the amounts of crude fats grew considerably in both silages. In the prepared wheat silage, the concentrations of crude protein, nitrogen free extract, ash increased. The higher concentration of crude protein, nitrogen free extract and low concentration of crude cellulose, ash was detected in the silage from *Hordeum vulgare*, which had a positive impact on net energy for lactation. It was found that the level of carotene in *Triticum aestivium* silage was significantly high.

Some authors mentioned various findings about the quality of preserved forage. According to HEIERMANN et al. (2009), the barley ensiled material in milk stage had pH=4.3 and contained 253 g/kg DM, 93.4% OM, 13.0 % CP, 24.6 % CF, 3.5% EE, 7.6 % sugar, 24.7 % starch; rye silage – pH=4.4, 329 g/kg DM, 93.2% OM, 11.9 % CP, 29.1 % CF, 2.2% EE, 11.3 % sugar, 0.5 % starch; triticale silage – pH=4.2, 412 g/kg DM, 94.6% OM, 8.8 % CP, 25.6 % CF, 2.1% EE, 22.0 % sugar, 0.6 % starch. BECK & JENNINGS (2014), mentioned that the dry matter content and the chemical composition of wheat ensiled material harvested in boot stage of maturity was: 215 g/kg DM, pH=4.8, 9.9 g/kg lactic acid, 0.9 g/kg acetic acid, 0.2 g/kg propionic acid, 0.8 g/kg butyric acid, 3.0 g/kg isobutyric acid, 23.0 g/kg ammonia, 16.8% CP, 37.1 % ADF, 58.5 % NDF, 60.0% DMD,

but wheat silage prepared in hard dough grain stage 467 g/kg DM, pH=5.1, 2.6 g/kg lactic acid, 0.2 g/kg acetic acid, 0.0 g/kg propionic acid, 0.1 g/kg butyric acid, 0.0 g/kg iso-butyric acid, 8.0 g/kg ammonia, 9.5% CP, 38.9 % ADF, 60.4 % NDF, 54.4% DMD, respectively.

Table 1.

The biochemical composition and nutritional value of fresh mass from studied winter cereal cultivars

| Indices | Cultivars | | | |
|---|---|---|---|---|
| | *Hordeum vulgare 'Excelent'* | *Triticum aestivium 'Moldova 614'* | *Triticale 'Ingen 40'* | *Secale cereale 'Zîmbreni 70'* |
| Crude protein (CP), % DM | 12.69 | 10.65 | 9.21 | 8.38 |
| Crude fats (EE), % DM | 3.08 | 2.78 | 3.17 | 2.83 |
| Crude cellulose (CF), % DM | 32.11 | 37.63 | 40.00 | 38.07 |
| Nitrogen free extract (NFE), % DM | 43.53 | 40.08 | 38.20 | 43.59 |
| Ash, % DM | 8.78 | 8.83 | 9.34 | 7.14 |
| Gross energy (GE), MJ/kg | 18.30 | 18.19 | 18.15 | 18.35 |
| Metabolizable energy (ME), MJ/kg | 8.92 | 8.26 | 8.14 | 8.45 |
| Net energy for lactation (NEl), MJ/kg | 4.96 | 4.45 | 4.38 | 4.63 |
| Calcium (Ca), g/kg DM | 3.30 | 2.30 | 2.40 | 3.00 |
| Phosphorus (P), g/kg DM | 2.10 | 2.40 | 2.90 | 2.30 |

Table 2.

The biochemical composition and nutritional value of silage from studied winter cereal cultivars

| Indices | Cultivars | |
|---|---|---|
| | *Hordeum vulgare 'Excelent'* | *Triticum aestivium 'Moldova 614'* |
| Dry matter content (DM), g/kg | 22.29 | 21.44 |
| pH index | 4.04 | 4.08 |
| Total organic acids, g/kg DM | 38.4 | 30.3 |
| Acetic acid, g/kg DM | 7.0 | 4.4 |
| Butyric acid, g/kg DM | 0 | 0 |
| Lactic acid, g/kg DM | 31.4 | 25.9 |
| Crude protein (CP), % DM | 12.67 | 11.08 |
| Crude fats (EE), % DM | 3.62 | 3.93 |
| Crude cellulose (CF), % DM | 31.39 | 37.99 |
| Nitrogen free extract (NFE), % DM | 43.63 | 41.53 |
| Soluble sugars (SS), % DM | 0.90 | 0.69 |
| Starch, % DM | 0.67 | 0.77 |
| Ash, % DM | 8.68 | 9.28 |
| Gross energy (GE), MJ/kg DM | 18.43 | 19.07 |
| Metabolizable energy (ME), MJ/kg DM | 8.77 | 8.43 |
| Net energy for lactation (NEl), MJ/kg DM | 5.09 | 4.54 |
| Carotene, mg/kg | 41.50 | 57.17 |

GEREN (2014) reported that the the quality of ensiled material from barley collected in different harvest stages was: pH 4.14-4.58, 8.8-11.7% CP, 33.9-38.5% ADF, 53.7-59.3 % NDF, but – from wheat pH=4.37-4.94, 9.3-12.1% CP, 37.3-42.6 % ADF, 55.7-61.2 % NDF, respectively. MAISAK & VOLOSHIN (2016) reported that the dry matter content and chemical composition of silage- from *Secale cereale* mowing in the beginning of earing stage were 193.4 g/kg DM, pH=3.9, 14.65% CP, 28.32% CF, 10.18 MJ/kg ME and 0.84 food units/kg absolute dry matter, but *Trticosecale* silages respectively

211.1-264.4 g/kg DM, pH=4.0, 12.97-15.80% CP, 29.94-30.42% CF, 9.74-9.88 MJ/kg ME and 0.77-0.81 food units/kg. According to ASKEL et al. (2017), the chemical composition of the haylage made from winter cereals was as follows: from *Secale cereale* – 9.08 % CP, 73.93 % NDF, 45.95 % ADF and 5.19 % ash; from *Trticosecale* – 10.55 % CP, 66.08 % NDF, 39.91 % ADF and 6.64 % ash; from *Hordeum vulgare* – 8.26 % CP, 71.50 % NDF, 39.56 % ADF and 4.21 % ash; from *Triticum aestivum* – 9.28 % CP, 71.98 % NDF, 42.32 % ADF and 4.30 % ash. LEÃO et al. (2017) compared the feed quality of winter cereal silages ensiled at the soft dough stage and subjected to different storage periods, remarked than wheat silage contained 55-95 g/kg CP, 41-48 g/kg ash, 663-666 g/kg NDF, 419-434 g/kg ADF, 228-246 g/kg HC, 499-508 g/kg TDN; barley silage 86-99 g/kg CP, 48-53 g/kg ash, 617-642 g/kg NDF, 331-378 g/kg ADF, 264-283 g/kg HC, 531-558 g/kg TDN, but triticale silage: 54-74 g/kg CP, 44-52 g/kg ash, 670-707 g/kg NDF, 416-446 g/kg ADF, 236-261 g/kg HC, 493-510 g/kg TDN. ŢÎŢEI (2018) compared the feed quality and energy value of cereals haylage prepared in milk ripe period found that triticale haylage contained 508.5 g/kg DM 9.24% CP, 2.89 % EE, 37.56% CF, 44.93 %NFE, 5.37% ash, but in rye haylage – 596.2 g/kg DM, 7.62% CP, 2.37% EE, 39.82 % CF, 45.51%NFE, 4.69 % ash. SEYDOSOGLU (2019) found that barley silage contained 320 g/kg DM, pH=4.11, 1.83% lactic acid, 14.43% CP, 30.05 % ADF, 44.39 % NDF and 8.66% ash.

## CONCLUSIONS

1. The fresh mass from winter cereals: *Hordeum vulgare* 'Excelent', *Triticum aestivium* 'Moldova 614', *Trticosecale* 'Ingen 40' and *Secale cereale* 'Zîmbreni 70' contain a lot of nutrients, which make them suitable to be used as forage sources during spring period, also for silage making.
2. The forages from *Hordeum vulgare* 'Excelent', had higher content of crude protein, nitrogen free extract, optimal crude fats and ash, low content of crude cellulose, which had a positive impact on metabolizable and net energy for lactation.

## ACKNOWLEDGEMENTS

The study has been carried out in the framework of the projects: 20.80009.5107.02 *"Mobilization of plant genetic resources, plant breeding and use as forage, melliferous and energy crops in bioeconomy"*

## REFERENCES

1. Askel E.J., Neumann M., Horst E.H., Santos J.C., Vigne G.L.D., Pontarolo G.B., Amaral B.H.C., Costa L., Sandini I.E. (2017). Chemical composition of forage and haylage of winter cereals in Guarapuava- –PR *http://www.isfqcbrazil.com.br/proceedings/2017/c hemical-composition-of-forage-and-haylage-ofwinter-cereals-in-guarapuava-pr-194.pdf*

2. Beck P., Jennings J. (2014). Using cool season annual grasses for hay and silage. *https://www.uaex.edu/publications/PDF/FSA3063.pdf*
3. Coşman S., Bahcivanji M., Coşman V., Garaeva S., Mitina T. (2018). *Ghid practic de date actualizate*. Maximovca, 58 p.
4. Coşman, S., Coşman V., Nițuliac T. (2021) *Ghidul practice al crescătorului taurinelor de lapte.* Maximovca, 123p.
5. Geren H. (2014) Dry matter yield and silage quality of some winter cereals harvested at different stages under Mediterranean climate conditions. *Turkish Journal of Field Crops*, 19(2):197-202.
6. Heiermann M., Ploechl M., Linke B., Schelle H., Herrmann C. (2009). Biogas crops-Part I:Specifications and suitability of field crops for anaerobic digestion. Agricultural Engineering International: The CIGR Ejournal XI, 1-17
7. Kahraryan B., Farahvash F., Mohammadi S., Mirshekari B., Rashidi V. (2021). Evaluation of yield, yield components and nutritive value in intercropping of barley with vetch. *Plant Science Today*, 8(2):373-379.
*https://doi.org/10.14719/pst.2021.8.2.871*
8. Khorasani G. R., Jedel P. E., Helm J. H., Kennelly J. (1997). Influence of stage of maturity on yield components and chemical composition of cereal grain silages. *Canadian Journal of Animal Science*, 77:259-267
9. Kocer A., Albayrak S. (2012). Determination of forage yield and quality of pea *(Pisum sativum* L.*)* mixtures with oat and barley. *Turkish Journal of Field Crops*, 17(1):96-99.
10. Leão G. F. M., Jobim C. C., Neumann M., Horst E. H., Santos S. K. dos, Venancio B. J., Santos L. C. (2017). Nutritional composition and aerobic stability of winter cereal silage at different storage times. *Acta Scientiarum. Animal Sciences*, *39*(2), 131-136. *https://doi.org/10.4025/actascianimsci.v39i2.34270*
11. Maisak G.P., Voloshin V.A. (2016). Winter crops yield at different times of mowing and silage quality and grain haylage in Middle Preduralie. *Perm Agricultural Bulletin*, 3(15): 41–48. *https://cyberleninka.ru/article/n/urozhaynost-ozimyh-kultur-pri-raznyh-srokah-skashivaniya-i-kachestvo-silosa-i-zernosenazha-v-srednem-preduralie*
12. Maşner O., Coşman, S., Macari V., Danilov A., Petcu I. (2021). *Bunele practici de adaptare a sectorului zootehnic la schimbările climatice: Ghid practic pentru producătorii agricoli.* Chișinău, 200 p.
13. Seydosoglu S. (2019). Effects of different mixture ratios of grass pea (*Lathyrus sativus* L.) and barley (*Hordeum vulgare*) on quality of silage. *Legume Research*, 42(5): 666-670
14. Ţîţei V. (2018). The quality of preserved biomass of some *Poaceae* species under the conditions of Republic of Moldova *Lucrări Ştiinţifice, seria Agronomie,* 61(1):177-182.
15. Ţîţei V., Blaj V.A., Marușca T., Andreoiu A.C., Mazăre V., Lupan A., Gore A., Scurtu G. (2018). Evalurea calității biomasei la unile specii din familia *Poaceae* cu utilizarea spectrofotometriei infraroșu apropiat (NIR). In: *Lucrări ştiinţifice. Agronomie şi Agroecologie,* 52(1): 58-65.
* SM 108:1995 (1996): Siloz din plante verzi. Condiţii tehnice. Moldovastandart. 10.