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Original scientific paper

WASTE FROM THE SUMMER PRUNING OF BERRY BUSHES SUITABLE FOR FEEDING BEEF CATTLE

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A b s t r a c t: The aim of the study was to use the harvested plant mass after summer pruning (green pruning) in various berry plantations, as a potential food source in beef cows. The experiment was conducted on female crossings F1 Hereford × Aberdeen Angus cows. The animals were fed in a controlled manner, with standardized amounts of fodder from regrowth and leaves, obtained after the summer pruning of berry crops (raspberries, blackberries, blackcurrants) with quantities up to 2.5 kg from the ration. The highest appetite was shown to the leaves and twigs obtained during the pruning of *Rubus idaeus* (combined group of two cultivars) with 49.7%, followed by those of *Ribes nigrum* – 31.2%, whereas the lowest was observed in feeding with those of *Rubus fruticosus* with 19.1%. The total amount of the three types of fodder is accepted as 100%. Compared to the other studied species, the foliar fodder of *Rubus idaeus* has the highest content of crude protein (10.20%), crude fiber (9.83%) and minerals (9.23%).

Key words: crossings; pruning; shoots; nutritional value; appetite; chemical composition

ОТПАД ОД ЛЕТНОТО КРОЕЊЕ НА ГРМУШКИ ЗА БОБИНКИ ПОГОДЕН ЗА ХРАНА НА ГОЈНИ ГОВЕДА

А п с т р а к т: Целта на студијата беше да се искористи собраната растителна маса по летното кроење (зелено кроење) на различни насади со бобинки, како потенцијален извор на храна за гојни говеда. Експериментот беше спроведен на крави крстоски од F1 Hereford × Aberdeen Angus. Животните беа хранети контролирано, со стандардизирани количества растителна маса и лисја, добиени по летното кроење на бобинки (малини, капини, црни рибизли), во количества до 2,5 kg од дажбата. Најголем апетит е покажан за листовите и гранчињата добиени при кроењето на *Rubus idaeus* (комбинирана група од две сорти) – 49,7%, потоа на *Ribes nigrum* – 31,2%, додека најмал е забележан при хранењето со *Rubus fruticosus* – 19,1%. Вкупното количество на трите видови зелена маса е прифатено како 100%. Во споредба со другите испитувани видови, лиснатата крма од *Rubus idaeus* има најголема содржина сурови протеини (10,20%), сурови влакна (9,83%) и минерали (9,23%).

Клучни зборови: крстоски; кроење; хранлива вредност; апетит; хемиски состав

INTRODUCTION

Summer pruning of the selective removal of leaf area during vegetation (Nikolova, 2012) have the potential to be absorbed and realized as an additional fodder reserve for feeding farm animals (Temel and Pehluvan, 2015; Nakov et al., 2022).

Depending on the type of pruning (winter or summer), a way is sought for more complete utilization of the removed branches, regrowth, shoots and leaves. According to Bilandzija et. al. (2012), the biomass as a result of winter pruning has a higher energy potential and is a suitable starting material for bioenergy production (Scarlat et al., 2011). Large amounts of biomass are obtained as a result of agrotechnical events (pruning) in the cultivation of fruit and vineyards (Dyjakon et. al., 2019).

There is still little information available on this issue and research and experiments continue (Damyanova, 2007).

This, in turn, favors the development of the circular economy, following the principle of using waste as raw material (Mirabella et al., 2014) in certain areas. In this context, in ruminant livestock, hay from natural meadows and pastures is one of the main sources of food for ruminants along with dried twigs and leaves during the autumn-winter period (Temel and Sahin, 2011).

In recent years, many scientists (Michailov et al, 2010; Nahand et al., 2011; Gulumser and Acar, 2012; Oktay and Temel, 2015) have accepted as an additional source of basic fodder crops, the use of foliar fodder, whose nutritional value depends on tree type and stage of development (Ghazanfar et al., 2011).

Lans et al. (2007) successfully fed pregnant cows with regrowth and leaves for several months in dried and fresh condition in British Columbia, Canada.

The chemical composition of foliar fodder contains the organic substances, such as lignin, cellulose, proteins, fats, waxes and resins (Brezin et al., 2013; Temel and Pehluvan, 2015). Other substances are also present in insignificant quantities, such as starch, sugars, proteins and pigments, composed of four chemical elements, such as carbon, hydrogen, oxygen and nitrogen.

The main purpose of the current study of plant waste is to use the material from summer pruning (green pruning) in various berry plantations, as an additional food resource in cattle breeding. Evaluation of the chemical composition and nutritional value of the obtained foliar fodder, as well as determination of the appetite of the different berry crops.

MATERIAL AND METHODS

The experiment was conducted in 2021 at the Research Institute of Mountain Stockbreeding and Agriculture – Troyan. In the experimental farm for beef cows (with meat-producing female crossings F1 Hereford × Aberdeen Angus). The animals are fed in a controlled manner with foliar fodder, obtained after summer pruning of berry crops (raspberries, blackcurrants, blackberries). The appetite of the fodder was monitored and determined by the method of "nursery cafeteria" Gillet et al. (1983). Appetite was determined by the amount of fodder consumed (taken as 100% of the animal's diet during the first 10–15 minutes). For the most appetizing fodder was determined the one with the highest consumption (Todorov et al., 2007).

Summer pruning was carried out during the period of May–June. It consisted with the removal of shoots and branches that shaded the inside part of shrubs. It largely shapes the shrub structure in the next year.

The chemical composition of the dried and ground leaf mass of berry crops includes analysis of: crude fiber (CF,%) by *Weende* analysis – the sample was treated sequentially with solutions of 1.25% H_2SO_4 and 1.25% NaOH; crude protein (CP,%) according to *Kjeldahl* (according to BDS/ISO-5983); crude fat (Cft,%) by extraction in a *Soxhlet* extractor and drying in a laboratory dryer at 95°C to constant weight (according to BDS/ISO-6492); ash (minerals,%) – gradual combustion of the sample in a muffle furnace at 550°C (according to BDS/ISO-5984); dry matter (DM,%) – empirically calculated from % moisture; calcium (Ca,%) by Stotz – complexometric determination; phosphorus (P,%) – with vanadate-molybdate reactive by a spectrophotometer (Agilent 8453 UV – visible Spectroscopy System) measuring in the area of 425 ηm and nitrogen-free extractable substances (NFE,%) = 100 – (CP,% + CF,% + Cft,% + ash,% + moisture,%).

The fiber composition of cell walls was determined by the method of Van Soest and Robertson (1979) and includes: Neutral detergent fibers (NDF, %), Acid detergent fibers (ADF,%), and Acid detergent lignin (ADL,%). Empirically calculated these are: Hemicellulose (%) = NDF – ADF and cellulose (%) = ADF – ADL. The degree of lignification is expressed as a percentage ratio (ADL/NDF)·100 (Akin and Chesson, 1990).

The analysis products Analysis Toolpak for Microsoft Excel 2010 and STATSOFT Statistics for Windows 10 were used for statistical data processing.

The data are presented in tables and figures.

RESULTS AND DISCUSSION

The use of the natural resources presented by the conducted research shows a very good symbiosis in the maintenance of orchards with the livestock farms.

Summer pruning of some berry species is an agrotechnical measure that contributes to the thinning of shrubs, semi-shrubs and thinning of fruit sets, and leads to a weakening of growth (vegetative) potential in different species and cultivars. The use of fallen leaf mass as animal feed is a major method for non-waste environmental technology.

The relative value of appetite accumulates all fodder qualities related to the intake and nutritional composition of fodder **(**Kirilov et al., 2016). The experimental female crossbred animals were granted free simultaneous access to three equal quantities of the tested foliar fodder. The results for appetite of the three fruit species are given in Figure 1. The highest appetite was shown to the leaves and twigs from the pruning of raspberries (*Rubus idaeus*) (combined group of two cultivars) with 49.7%, followed by those of the blackcurrant (*Ribes nigrum*) (combined group of two cultivars) with 31.2%, whereas the lowest value was observed in feeding with those of blackberries (*Rubus fruticosus*) with 19.1%. The total amount of the three types of foliar fodder is accepted as 100%. The share of the total amount was calculated according to the amount of foliar fodder of each species eaten.

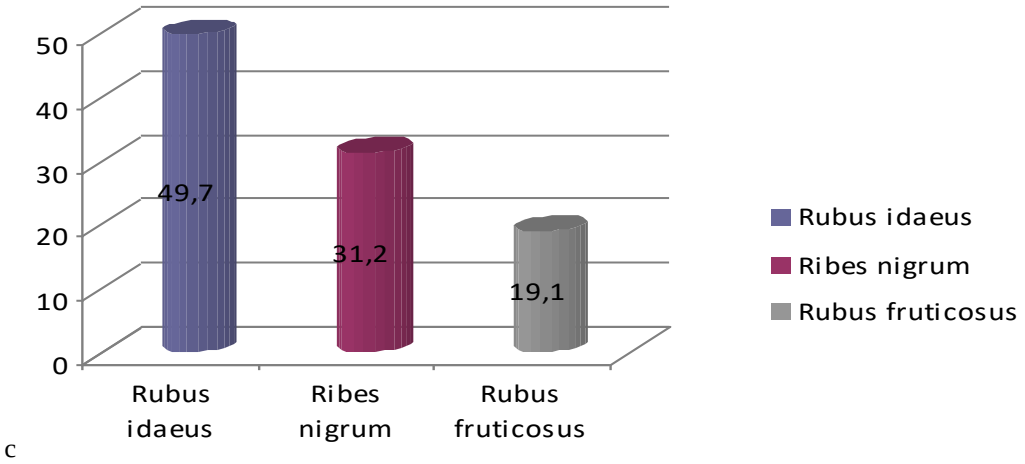

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Fig. 1. Appetite of foliar forage from berry species (% of total consumption)

The amount of fodder consumed during the first 15 minutes of feeding determines the appetite of each of the studied species. The values for appetite are relative values for the studied berry species, which give a general idea of their fodder qualities. The most palatable fodder was the one with the highest consumption (Todorov et al., 2007).

The provision of basic grains and fodders is an effective and comprehensive measure for feeding farm animals (Wadhwa et al., 2015). According to Sahoo et al. (2010), the amount of macronutrients in foliar fodder is of great significance for the normal course of physiological processes (especially for young growing up animals), as foliar mass is highly digestible and high in nitrogen. Compared to the other studied species, the foliar fodder of *Rubus idaeus* has the highest content of crude protein (10.20%), crude fiber (9.83%) and minerals (9.23%) (Table 1).

Table 1

Basic chemical composition (%, DM) of dry leaf mass in some berry crops

Foliar fodder	DM	CP	CF	Cft	Ash	NFE	Ca	P
Rubus fruticosus	89.52	8.99	8.11	17.83	8.56	46.04	3.71	0.03
Rubus idaeus	89.77	10.20	9.83	18.23	9.23	42.30	3.70	0.03
Ribes nigrum	90.03	10.13	7.64	18.63	8.88	44.76	3.51	0.02

The dry leaf mass of the species *Ribes nigrum* has the highest content of dry matter (90.03%) and crude fat (18.63%), whereas the leaf mass of *Rubus fruticosus* has the highest carbohydrate content (46.04%). Compared to other studied berry species, *Rubus fruticosus* foliar fodder has the lowest concentration of dry matter (89.52%), crude protein (8.99%), crude fat (17.83%) and ash (8.56%). Studies show almost identical values for the content of macronutrients, such as calcium (3.70–3.71%) and phosphorus (0.03%) in the dry matter composition of foliar fodder of species of the genus *Rubus*. *Ribes nigrum* has the lowest concentration of crude fiber (7.64%), calcium (3.51%) and phosphorus (0.02%).

The content of fibrous structural components in the cell walls is essential for the uptake and digestibility of fodder, as well as for the productivity of farm animals (Chourkova, 2012; Naydenova and Vasileva, 2016). The analysis of data shows that the dry leaf mass of blackberry plantations has the lowest values of neutral-detergent fibers (25.57%), acid-detergent fibers (15.33%) and cellulose (6.12%) (Figure 2).

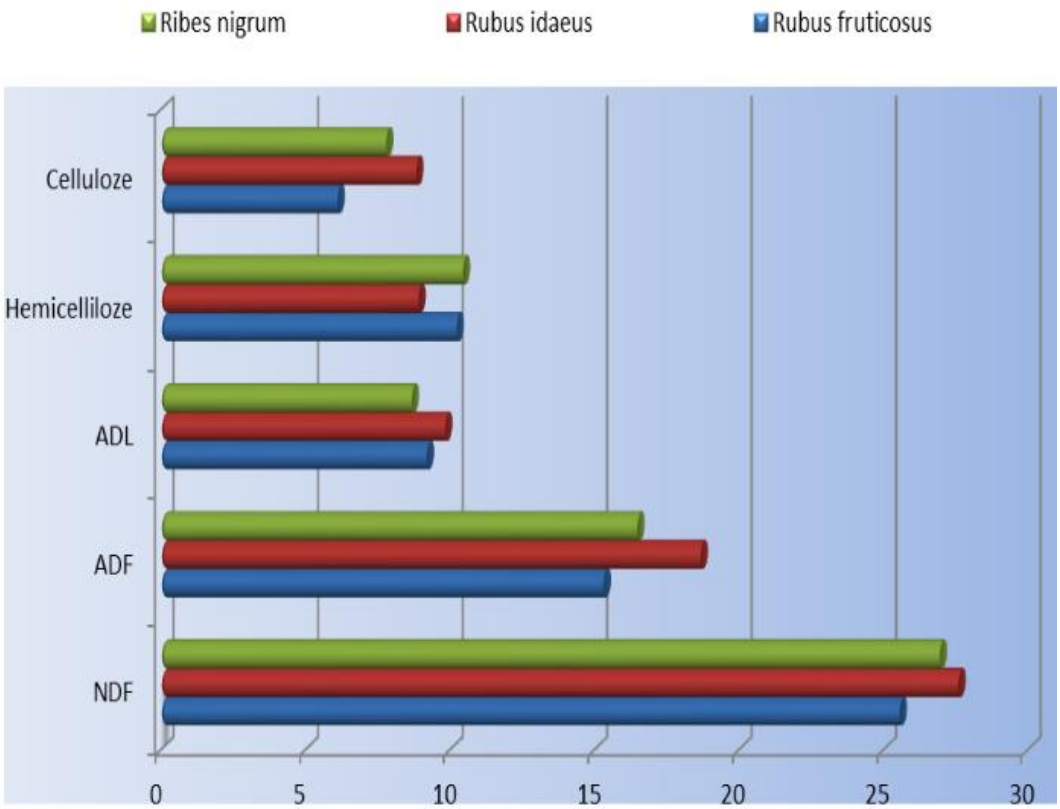

Fig. 2. Structural fiber components (%, DM) of dry leaf mass in some berry crops

Leaf fodder obtained after cutting blackcurrant above ground part recorded the lowest concentration of acid-detergent lignin (8.69%) and the highest of hemicellulose (10.46%).

Compared to other studied species, the leaf mass of *Rubus idaeus* has the highest values in terms of NDF (27.61%), ADF (18.69), ADL (9.85%) and cellulose (8.85%), and the lowest of fully digestible from animals' polyoside – hemicellulose (8.92%).

The lower degree of lignification is the result of a lower concentration of acid-detergent lignin in the cell walls. The lowest degree of lignification (29.99) is observed in the leaf mass of *Ribes nigrum* (Figure 3). The values of the indicator for the species of the genus *Rubus* exceeded by 19.8% (*Rubus idaeus*) and 20.1% (*Rubus fruticosus*), respectively.

The results of the present study correspond in value, and in some respects complement the data obtained by Lans (2007), Damyanova (2007) and Michailov et al. (2010).

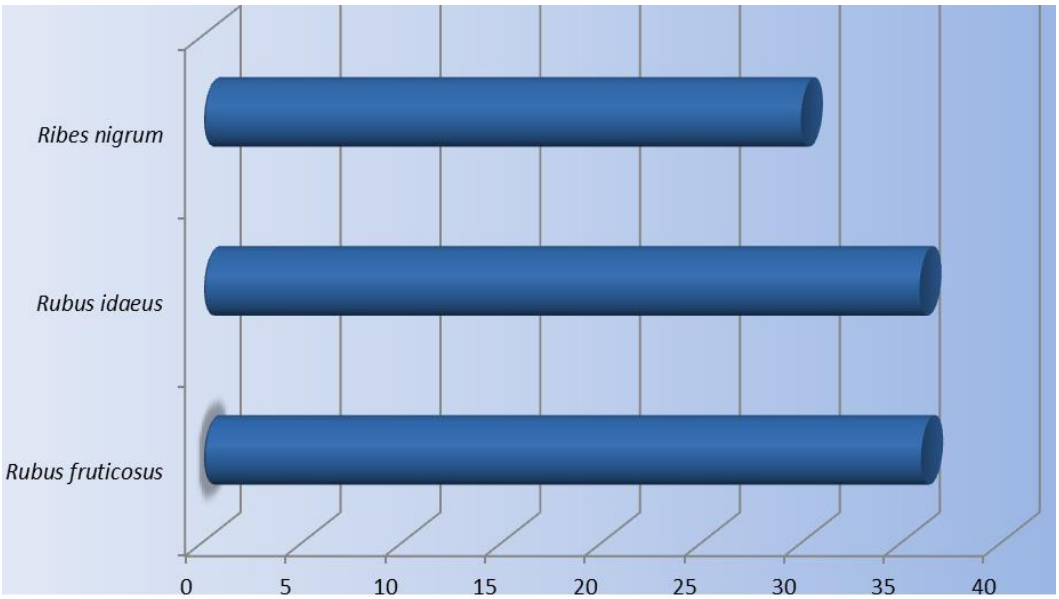

Fig. 3. Degree of lignification of dry leaf mass in some berry crops (coefficient)

CONCLUSIONS

Derivatives of summer pruning can be used in standardized quantities for feeding beef cattle in the foot-hill and mountainous regions of Bulgaria. Technological process for waste-free summer pruning is closely related to the use of waste twigs and leaves to supplement the rations of cattle. The total amount of the three types of fodder is accepted as 100%. The highest appetite was shown to the leaves and twigs from the pruning of *Rubus idaeus* (combined group of two cultivars) with 49.7%, followed by those of *Ribes nigrum* with 31.2%, whereas the lowest was observed in feeding with those of *Rubus fruticosus* with 19.1%. Compared to the other studied species, the foliar fodder from *Rubus idaeus* had the highest content of crude protein (10.20%), crude fiber (9.83%) and minerals (9.23%).

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Declaration of conflict of interest*:* We declare that there is no established conflict of interest in the absence of trade and financial relations.

Data availability declaration**:** Raw data supporting the conclusions of this article will be provided by the authors upon request.

Declaration of ethics**:** All ethical norms are observed.

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