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EVALUATION OF SOME CHEMICAL COMPOUNDS IN *Foeniculum vulgare*, *Trigonella foenum-graecum*, AND *Cuminum cyminum* SEEDS AS POTENTIAL FOOD SUPPLEMENTS FOR COWS

Paula POSAN[1], Lucica NISTOR[1], Violeta Alexandra ION[2], Aurora DOBRIN[2], Andra SULER[1], Dana IANITCHI[1], Nicoleta DEFTA[1], Monica MARIN[1]

[1]University of Agronomic Sciences and Veterinary Medicine of Bucharest, Faculty of Animal Productions Engineering and Management, 59 Marasti Blvd, District 1, Bucharest, Romania
[2]University of Agronomic Sciences and Veterinary Medicine of Bucharest, Research Center for the Study of Quality Food Products, 59 Marasti Blvd, District 1, Bucharest, Romania

Corresponding author email: andrasuler@yahoo.com

Abstract

The present study investigates the chemical composition of seeds from Foeniculum vulgare (fennel), Trigonella foenum-graecum (fenugreek), and Cuminum cyminum (cumin) to assess their suitability as food supplements for enhancing milk production in cows. The dry matter, ash content, total nitrogen, total carbon, protein and fiber levels were analyzed to provide comprehensive insights into the nutritional value of these seeds. The experiments in this study were all conducted in triplicate. Results were defined as mean values ± standard deviations. The results are part of a larger project and these findings are integral to the broader project, which aims to develop optimized dietary supplements for dairy cattle. Considering the essential role of nutrition in dairy cattle health and milk production, the identified nutritional components in these seeds hold promise for incorporating them into cattle diets.

Key words*: chemical composition, cow, galactogenic effect, medicinal plants, milk production.*

INTRODUCTION

Engaging in animal husbandry at the household level grips a significant role in rural economies, offering families a stable income stream and a dependable source of food.

Given the conditions of the world population explosion, an important concern for securing food resources is cattle rearing and exploitation, as this animal species provides raw material for a wide range of food products. Even though the cattle livestock has decreased, milk production has to increase, and farmers need to be interested in exploiting animals with high production potential and ensuring optimal conditions for animal welfare (Defta et al., 2023).

Also, the increasing demand for organic animal products, coupled with restrictions on medicinal substance use and the quest for alternatives to traditional feed additives, underscores the growing interest in natural approaches to enhance milk production. Herbal spices emerge as potential contributors to altering animal diets, with the ultimate aim of positively impacting the secretory tissue of the mammary gland (Mohanty et al., 2014). This influence is anticipated to lead to an enhancement in milk production, aligning with the broader trend towards natural solutions in response to evolving agricultural and health considerations Penagos et al., 2014; Marin et al., 2020.

Researchers have shown a particular interest in galactogenic plants due to their accessibility, affordability, and the absence of toxic residues in milk. Exploring the phyto-pharmacological aspects of medicinal plants holds promise for uncovering innovative methods to incorporate galactogenic plants into the diets of dairy animals. Numerous plants contain a rich array of chemically active compounds with galactogenic properties, presenting viable opportunities for utilizing herbal remedies to augment milk production in animals.

Phytochemical analysis uncovered the presence of active compounds, including phenolic acids such as caffeic acid and chlorogenic acid, α-linolenic acid, curcumin, essential oils like eugenol and limonene, flavonoids such as quercetin and rutin, as well as trigonelline, gentianine, saponins, and galactomannan. These

compounds collectively contribute to the galactopoietic effect, as documented by Bharti et al. (2012).

The use of galactogenic plants, as a natural supplement for the growth and support of milk production, is in line with global trends to ensure animal health and welfare for animals and to obtain clean production unaltered by medicinal chemicals, which can be found in milk secretion, thus ensuring the premises for food safety and security. Some of the most used plants in these studies are *Foeniculum vulgare*, *Trigonella foenum-graecum*, and *Cuminum cyminum* seeds, with satisfactory results (Posan et al., 2023).

Several researchers have conducted studies administering these plants to cows at doses ranging from 50 g to 150 g per animal per day. Their findings have demonstrated beneficial effects on both productive qualities (such as improved udder health, oxytocic effects promoting milk ejection by stimulating mammary gland ducts, increased activity of mammary gland alveolar tissue, and enhanced secretory activity of glandular acini) and reproductive aspects (including estrogenic effects, regulation of the sexual cycle, and uterotonic effects) in the respective females (Waghorn et al., 2003; Patel et al., 2016; 2017; Bora et al., 2019; Bhargav et al., 2021).

Recognizing the importance of milk in both human and animal nutrition, but facing pressure to reduce the dairy cattle population due to their implication in methane emissions, contributing to the rise in greenhouse gas concentrations, there is a need to find a sustainable strategy for maintaining high-level milk production. In the year 2020, the European Union maintained a population of around 20 million cows, each yielding an average of 7,300 kg of milk. Projections indicate a continued decline in the number of dairy cows, with an anticipated drop below 20 million by the year 2023. This reflects a reduction of 1.7 million cows since the peak in 2016 and a decrease of 564,000 cows since 2021 (Mihai et al., 2023).

Maintaining the same level of marketable milk quantity, involves increasing production per head of cattle, and the use of galactogenic plants as a dietary supplement can be a viable solution. The current research examines some of the chemical components (dry matter, ash content, total nitrogen, total carbon, protein and fiber levels) of seeds from *Foeniculum vulgare* (fennel - FVE), *Trigonella foenum-graecum* (fenugreek - FGI), and *Cuminum cyminum* (cumin - CI) to evaluate their potential as food supplements for improving milk production in cows.

Fenugreek is widely recognized as one of the most commonly utilized herbal galactogogues. Belonging to the Leguminosae family, it is cultivated extensively in various regions worldwide, with notable cultivation in India, Mediterranean countries, North Africa, and Southern Europe (Abascal & Yarnell, 2008). Fennel, the sole species in the Foeniculum genus, is distributed across temperate zones globally. This perennial and aromatic plant is indigenous to southern Europe, particularly the Mediterranean coast, where it thrives as a wild herb (Manzoor et al, 2016). *Cuminum cyminum*, commonly known as Cumin and belonging to the Apiaceae family, is native to regions spanning from the East Mediterranean to South Asia (Sharif et al., 2018).

While these plants generally originate in the Mediterranean region, they can also be grown in Romania and can be acquired from local producers of medicinal and aromatic plants.

The current study is part of a wider research and besides these elements of chemical composition, determinations of active biological compounds will be made in fennel, fenugreek, and cumin, comparing the seeds grown in other geographical regions (Egypt, India), with those of plants grown in Romania in order to assess the opportunity of their utilization as supplements in the diet of dairy cows.

MATERIALS AND METHODS

The analyses were carried out on seeds of *Foeniculum vulgare*, *Trigonella foenum-graecum*, and *Cuminum cyminum* and the values were reported as percentage of the raw seeds. The seeds were commercially acquired and originated from India (FGI and CI) and Egypt (FVE). From each type of seed, three samples of 200 g each were extracted, labeled as 1, 2, and 3. Prior to analysis, the samples were ground using a grinder for 10 seconds and passed through a 1 mm sieve.

The dry matter, ash content, total nitrogen, total carbon, protein and fiber levels were analyzed to

provide comprehensive insights into the nutritional value of these seeds. The experiments in this study were all conducted in triplicate. Results were defined as mean values ± standard deviations.

The determination of dry matter content (DM %) was carried out using the gravimetric method, involving the removal of water through evaporation and weighing, in accordance with the European Pharmacopoeia 7th edition, and the results were expressed in percentages.

The ash determination was conducted following the AOAC Official Method 942.05, "Ash of Animal Feed," using a muffle furnace, and the results were expressed in percentages.

The analysis of total nitrogen content (N%) and total carbon content (C%) was conducted using the Dumas method, employing the elemental analyzer EA 3000, and the protein quantity was calculated by multiplying the total nitrogen content by a factor of 6.25.

The determination and quantification of fibers were performed using the Acid Detergent Fiber (ADF) method according to Van Soest, and, in the end, the calculation formula was applied:

$$ADF\% = \frac{(CW + RW) - CW}{SW} \times 100$$

ADF% = Acid Detergent Fiber
CW - weight of the crucible
RW - weight of the residue
SW - weight of the sample

RESULTS AND DISCUSSIONS

In tables and figures 1, 2, and 3, the values of dry matter and humidity are presented and these parameters exhibit a high degree of similarity among the seeds of the three plant species.

Analysing the dry matter content in galactogenic seeds is crucial for understanding their nutritional composition, formulating effective animal diets, ensuring storage stability, and promoting optimal milk production in livestock.

Table 1. Dry matter and moisture percent for Fennel

Specification	$\bar{x}_{\pm s\bar{x}}$	v %
Dry matter, %	90.97 ± 0.101	0.111
Humidity, %	9.03 ± 0.101	0.115

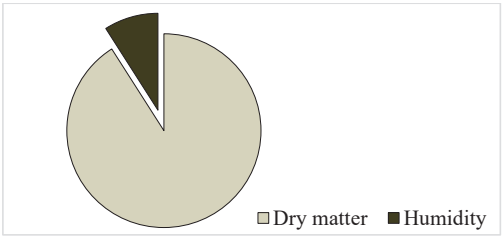

Figure 1. Dry matter and moisture percent for Fennel

In the present study, the dry matter content in fennel seeds measured 90.97%, closely aligning with values reported by other researchers, who found a maximum of 92% (Saber & Eshra, 2019). Consequently, the humidity percentage was 9.03%, differing from the average reported by Hina in 2014 (6.24 ± 0.24). Mehra's 2021 research reveals variations in humidity levels within fennel seeds, ranging from 8.45% to 5.85%, contingent upon their variety or genotype.

Table 2. Dry matter and moisture percent for Fenugreek

Specification	$\bar{x}_{\pm s\bar{x}}$	v %
Dry matter, %	90.51 ± *0.044*	*0.049*
Humidity, %	*9.49* ± *0.044*	*0.464*

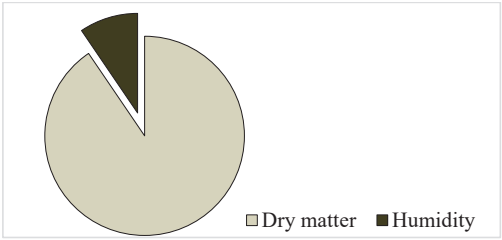

Figure 2. Dry matter and moisture percent for Fenugreek

The dry matter content discovered for Fenugreek in this study, at 90.51%, closely mirrors the findings of Zemzmi et al. (2020), who reported 90.2%. The moisture percentage (9.49%) falls within the range observed by Agrawal et al. in 2015 (11.21%) and Wani & Kumar in 2018 (8.18%).

Table 3. Dry matter and moisture percent for Cumin

Specification	$\bar{x}_{\pm s\bar{x}}$	v %
Dry matter, %	90.49 ± 0.085	0.094
Humidity, %	9.51 ± 0.085	0.464

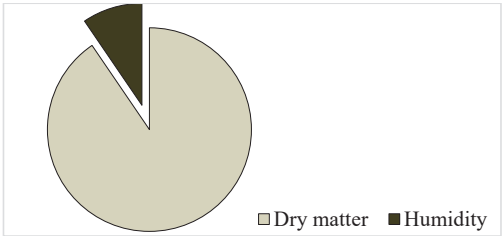

Figure 3. Dry matter and moisture percent for Cumin

The percentage of dry matter for Cumin seeds had an average of 90.49%, a value slightly lower than that found by Kha & Chaudhry in 2010 (96.4%).

In table 4 and figure 4 are presented the percent of ash, from raw seed.

Table 4. Ash percent for Fennel, Fenugreek and Cumin

Specification	$\bar{x} \pm s_{\bar{x}}$	v %
Fennel	8.798 ± 0.241	2.738
Fenugreek	3.317 ± 0.040	1.209
Cumin	6.957 ± 0.195	2.803

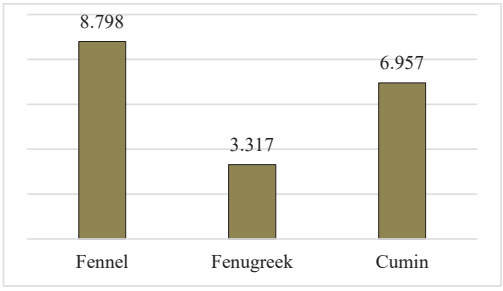

Figure 4. Ash percent from raw seed, for Fennel, Fenugreek and Cumin

In this study, ash content values were determined as 8.79% for fennel, 3.31% for fenugreek, and 6.95% for cumin. These values differ from other researchers, which reported for fennel values ranged between 9.38% and 12.87% (Saber & Eshra, 2019, Mehra et at., 2021, Hina et al., 2014) 3% (Agrawal et al., 2015), and 10.1% for fenugreek (Zemzmi et al., 2020), and 8% for cumin (Kha & Chaudhry, 2010).

In tables 5, 6, 7 and figures 5, 6, and 7 are presented the percentage values of total nitrogen, total carbon and protein from the three types of raw seeds.

Table 5. Total nitrogen percent from raw seed, for Fennel, Fenugreek and Cumin

Specification (N%)	$\bar{x} \pm s_{\bar{x}}$	v %
Fennel	2.494 ± 0.078	3.147
Fenugreek	6.345 ± 0.067	1.059
Cumin	2.369 ± 0.171	7.217

Nitrogen content in galactogenic seeds is pivotal for assessing their potential as feed supplements for enhancing milk production. It provides insights into the protein quality, amino acid composition, and overall nutritional value, influencing the effectiveness of these seeds in promoting lactation in animals.

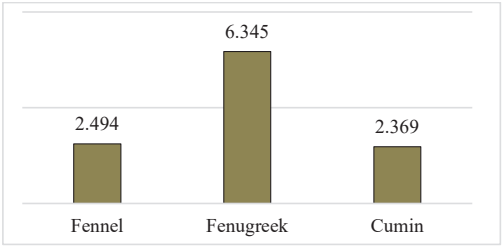

Figure 5. Total nitrogen percent from raw seed, for Fennel, Fenugreek and Cumin

It is observed that the nitrogen values are higher in fennel, compared to those of fennel and cumin. Factors such distinct genetic and metabolic profiles, soil composition, cultivation conditions, and environmental factors can contribute to variations in nutrient levels.

Table 6. Total carbon percent from raw seed, for Fennel, Fenugreek and Cumin

Specification	$\bar{x} \pm s_{\bar{x}}$	v %
Fennel	50.779 ± 1.318	2.596
Fenugreek	47.822 ± 0.137	0.286
Cumin	49.609 ± 2.025	4.082

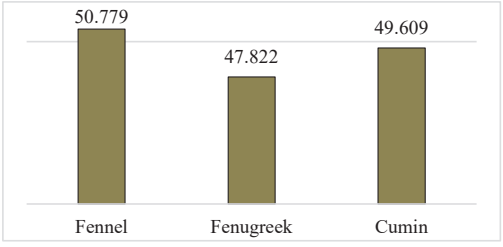

Figure 6. Total carbon percent from raw seed, for Fennel, Fenugreek and Cumin

While nitrogen content is more directly associated with protein synthesis and milk production, carbon content in galactogenic seeds contributes to the energy component of the diet. Balancing both nitrogen and carbon content is crucial for formulating diets that support optimal milk production and overall animal health.
The carbon values recorded were 50.7% for fennel, 47.8% for fenugreek, and 49.6% for cumin. These values are consistent with those reported by other researchers (40.19% for fennel, Saber & Eshra, 2019; 55.49 % Agrawal et al., and 52.3% Wani & Kumar, 2018, for fenugreek).

Table 7. Protein percent from raw seed, for Fennel, Fenugreek and Cumin

Specification	$\bar{x} \pm s_{\bar{x}}$	v %
Fennel	15.590 ± 0.491	3.147
Fenugreek	39.656 ± 0.420	1.059
Cumin	14.808 ± 1.069	7.217

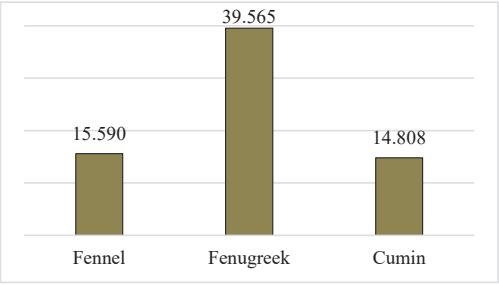

Figure 7. Raw seed total protein from for Fennel, Fenugreek and Cumin (%)

The protein content in seeds is an important factor in determining their nutritional quality. The protein content in these seeds is essential for providing necessary nutrients to animals, supporting growth, and ensuring overall health.
The protein value of the analysed seeds was slightly higher than that found in other authors' studies: 15.59% for fennel, compared to 10.18% (Saber & Eshra (2019) or 12.97% (Hina et al., 2014); 39.56% for fenugreek, compared to 20.9-24.7% (Kha & Chaudhry, 2010), 23.30% (Agrawal et al., 2015), 23-26% (Wani & Kumar in 2018) or 27.57% (Dhull et al., 2021). For cumin seeds the situation is the opposite, the values found in this study (14.8 %) being lower than those found in other authors (22.3% (Kha & Chaudhry, 2010)

In table and figure 8, the percentage values of ADF from raw seed, for the three types of seeds are presented

Table 8. ADF % from raw Fennel, Fenugreek and Cumin seeds

Specification	$\bar{x} \pm s_{\bar{x}}$	v %
Fennel	39.458 ± 0.758	1.921
Fenugreek	14.215 ± 0.739	5.198
Cumin	34.745 ± 1.344	3.868

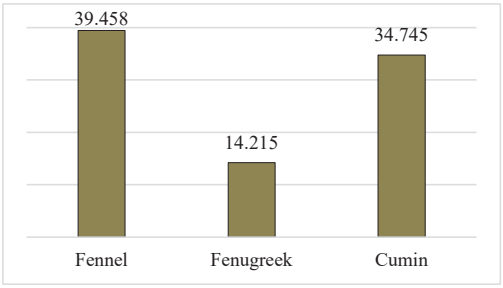

Figure 8. ADF % from raw seed, for Fennel, Fenugreek and Cumin

Acid Detergent Fiber analysis is a valuable tool in assessing the fibrous components of forages and feeds, providing critical information for optimizing animal nutrition, diet formulation, and overall farm management.
In this study, ADF recorded values of 39.45% for Fennel, 14.21% for Fenugreek and 34.74% for Cumin. For Fennel Hina et al. (2014) found values of 43.44%, for Fenugreek Jiang et al. (2007) found values of 26.8%, and Zemzmi et al. (2020), found values of 24.6%. For cumin, the value presented by Kha & Chaudhry (2010) was 24.1%.
The difference in ADF recorded between the different seed samples suggests different values of cellulose, lignin and cutin in the fiber composition of these plants

CONCLUSIONS

Analysing some chemical components provides comprehensive information that is essential for both scientific research and practical applications, especially in the context of using these seeds to enhance milk production in animals. The examination of seed samples indicated that the recorded values align with those reported by previous researchers. Some

variations in the values of dry matter/moisture, ash, nitrogen/carbon/protein content, and ADF between the present study and the cited literature arise due to the analysis of plants belonging to different varieties or genotypes, grown under varying soil conditions, temperatures, and cultivation techniques Understanding the chemical composition of these seeds is essential for their proper incorporation into animal feed. This ensures that the seeds can express their maximum potential, ultimately fulfilling their intended purpose, which is to enhance milk production in animals.

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