STUDY REGARDING THE USE OF MULBERRY LEAVES FROM EFORIE VARIETY BY *BOMBYX MORI* - ZEFIR HYBRID

STUDIU PRIVIND UTILIZAREA FRUNZEI DE DUD DIN SOIUL EFORIE DE CATRE HIBRIDUL DE *BOMBYX MORI* – ZEFIR

DOLIŞ M.G.[1] , ANTOHE R.G.[2] , BERNARDIS R.[1], RAȚU Roxana Nicoleta[1] IVANCIA Mihaela[1*]

[*]Corresponding author e-mail: mivancia@uaiasi.ro

Abstract. *During the growth of silkworm larvae (the Bombyx mori Zefir larvae hybrid) study, also was done a research which aimed to determine the chemical composition and the digestibility of mulberry leaves from a Romanian variety, Eforie. The results showed that advancing in the vegetation stage at the same time with different periods of the silkworm larvae's growth, the mulberry leaves experience an aging process being noticed through its quality decreasing from chemical composition point of view. So, for example, the CP which was in average 20.98± 0.670% (from DM), decreased during the study with 3.11%; while the CF had an average of 17.91± 0.434%, (from DM) increased with 2.29%. The digestibility of these nutritional components registered a value of 57.21%, the raw energy value was 4213 kcal/kg dry substance, the digestive energy was 2324 kcal/kg (DS), while the metabolic energy was 2154-2157 kcal/kg (DS). The efficiency of converting ingestion into silk had a value of 9.50% and the digestion was 16.61%.*

Key words: leaves, Mulberry, larvae, energy, use

Rezumat *Pe parcursul creşterii unei serii de viermi de mătase (hibridul de Bombyx mori Zefir) au fost efectuate o serie de cercetări menite să determine, în principal, evoluția compoziției chimice şi a digestibilității frunzei provenită de la soiul romînesc de dud Eforie.Rezultatele au arătat ca odată cu înaintarea în vegetație şi implicit pe parcursul fiecărei perioade de creştere a larvelor de mătase, frunza de dud suferă un proces de îmbătrânire, tradus prin diminuarea calității acesteia din punct de vedere al compoziției chimice. De exemplu, PB, care în medie a avut o valoare de 20,98± 0,670% (din SU), a înregistrat o descreştere de 3,11%, în timp ce CB, cu o valoare medie de 17,91± 0,434% (din SU), a cunoscut o creştere cu 2,29%. În concordanță cu acest fapt, la majoritatea substanțelor nutritive din frunza de dud, cu excepția celulozei, s-a observat o scădere continuă a digestibilității de-a lungul perioadei de creştere. Digestibilitatea substanțelor nutritive din frunză, în ansamblu, a înregistrat o valoare de 57,21%. Valoarea energetică a frunzei a fost de 4213 Kcal/kg SU (EB), 2324 Kcal/kg SU (ED), 2154-2157 Kcal/kg SU (EM). Eficiența conversiei ingestei (ECI) în mătase de 9,50%, respectiv a digestei (ECI) de 16,61%.*

Cuvinte cheie: frunză, dud, larve, energie, valorificare

[1]University of Agricultural Sciences and Veterinary Medicine from Iaşi, Romania
[2]Bucharest University of Economic Studies, Romania

INTRODUCTION

The success in growing silkworms process is influenced by several factors in which the nutrition plays a decisive role. The quality of mulberry leaves administered in larvae feeding directly influences not only the growth, their health and vitality but also the qualitative and quantitative silk production.

The leaves quality is also influenced by several factors related to pedoclimatic conditions, season, mulberry variety and so on.

Therein have been done and still are presently done studies on nutritional value of the mulberry leaves administered in *Bombyx mori* larvae feeding and their influencing factors. Those studies use fairly complex methods which among other things, in addition to leaves chemical composition determining implies also digestibility tests.

Studies regarding the nutritive value of the mulberry leaves have not only targeted their usage for the *Bombyx mori* species but also for swine, sheep, goats, cattle, rabbit, and poultry.

As well, studies regarding qualitative traits of mulberry leaves (and at times, fruits) were done for medicinally and therapeutically purposes.

In Romania, apart from imported and acclimated mulberry varieties were also created local ones, some quite valuable, such as: Galicea 1 and 2, Orşova 6, Eforie, Lugoj, Calafat, Vlădila, Basarabi and so on.

Studies done to determine the leaves nutritive value of local mulberry varieties are quite rare, obsolete and incomplete meaning that most of them were done in 60's and 70's and make references more to the chemical composition of the leaves.

At the end of the last century, Romania could be considered an important point on the map of European sericulture. Thus, in her record, Romania can boast in this field with a quite complex literature, as well as with the creation of new varieties and valuable hybrids of worm, as *Bombyx mori*, all being the result of some decade research work of Romanian specialists (Doliş, 2008; Lazăr and Vornicu, 2013; Pătruică, 2013).

For this reason, we consider appropriate to bring a modest contribution to the study of using the mulberry leaf, derived from indigenous varieties, by larvae of breeds or hybrids created in Romania.

MATERIAL AND METHOD

The research was done during the growth period of the silkworm larvae from summer series, the biologic material being represented both by silkworm larvae and mulberry leaves which were administrated. The animal material used in the experiments was represented by a batch of 150 larvae of *Bombyx mori* from Romanian simple hybrid *Zefir*. To be easier to follow, the group was devided into three sub-lots (repetitions) of 50 larvae each, which were raised in paper trays sized according to the age and size of the larvae; in addition, it was also made up a separate lot, with 50 larvae reared separately, but under the same conditions, which served to replace the dead larvae from the experimental group.

The growth of the larvae was in August, in an air-conditioned room, in compliance with all the microclimate factors. Each divided group received the same amount of leaf, from the same variety of worm, *Eforie,* from where samples were previously collected, for chemical analysis.

The Romanian variety of mulberry *Eforie*, which is characterised by a high production capacity, an early budding and a high resistance to freezing and drought. It was selected from a local population from Dobrogea in 1955 and introduced into production in 1970.

Daily and at the same time, from each group were collected, weighed and recorded what was not consumed from the Mulberry leaves and what was excreted by the larvae.

The quantities of residues, respectively of excrements, obtained from each group were summed, the result being divided into three, thus obtaining the average quantity of residues from each 50 larvae. The values obtained were subsequently used in the calculation relationships to find the digestibility coefficients. Also, from each group were collected samples of excrements, which were mixed in order to obtain medium samples for analyze.

Also, the groups were weighed at the beginning of growth (after hatching) and at the end (before budding), the difference between the two weights, divided by the number of larvae in each group, representing the increase in body mass accumulated by a larva.

From the separated lot were extracted 10 larvae, whose content was determined in dry matter; thus, multiplying the average dry substance content of larvae, calculated from the separated lots, with the increasing body mass of the larvae in the experimental lots, it was determined the average increasing of body mass of a larva.

After gobbling, 15 cocoons were harvested, from which the silk wrapper was separated, weighed and its dry matter content determined, thus obtaining the average dry wool content of the silk wrapper.

The working methods used were mainly the specific ones used to determine the nutritional value of the worm leaf and they were based on the chemical composition (the "proximate analysis" scheme), the digestibility of its components (the "in vivo" method - simple digestibility, with a single control period) and raw energy (use of specific computation equations and regression coefficients recommended by the OKIT system), digestible (calculation equation recommended for monogastric species) and metabolizable (equations recommended for monogastric animals and birds) contained (Halga *et al.,* 2005).

The efficiency of the use of nutrients in the worm leaf by the larvae was expressed by the amount of ingested/digested dry matter required for increasing 1 gram of body mass/weight (silk wrap), respectively by the efficiency of conversion of ingested substances (ECI%) / digested (ECD%) in body mass/weight (Matei, 1995; Rahmathulla *et al.,* 2002; Sarkar, 1993).

RESULTS AND DISCUSSIONS

The average relative humidity of the mulberry leaves during the research was 70.44%, and a decreasing evolution being registered average values between 71.86% (at the first determination corresponding to the first age of the silkworm larvae) and 68.15% (to the last determination when the silkworm larvae are in the age V-th). The dry matter represented 29.56 ± 0.725% (tab. 1).

In the specific literature, depending on different factors, the relative humidity values of the Mulberry leaf vary between 65-75% (Doliş, 2008).

Compared with the common Mulberry (69.80-73%), the selected varieties have more water content (Bura *et al.,* 1995). The dried substance from the worm leaf, harvested in the same period, can record, depending on the variety/hybrid, different values, for example, between 23.61% and 27.56% (Matei, 1995).

Also, if the spring moisture of the mulberry leaf is 71.85-77.81%, then it decreases to 68.42-75.64%, in the summer period, respectively to 64.10-73.64%, in the fall (Ifrim, 1998).

The crude protein had an average value of 6.18% (20.98±0.670% from DM). It is noticed a progressive decreasing of the protein content throughout the studied period, the content decreasing being with 3.11 percentage points, from 22.14% to 19.03%, respectively (tab. 1).

The raw leaf protein is estimated to have an average value of 6.16% in the fresh leaf, 20.97% in the dry substance and 24.36% in its organic substance (Doliş, 2008). The raw leaf protein values can vary depending on the season, the time of day, the variety/hybrid of the dude: 32.40% in spring, 28.21% in summer and 24.53% in autumn (Borcescu, 1966), 26.80% in the morning and 29, 10% in the evening (Mărghitaş, 1995), between 22.55% and 25.73% depending on the variety (Matei, 1995).

The fat content from the mulberry leaves was in average 1.10% in the fresh leaves, and 3.70%±0.260 in DM. It is the only nutrient with a high variability, of 15.70%. The fat content increased uniformly throughout the silkworm larval growth, from 0.85% to 1.38% when it was expressed in fresh leaves, or 3.2% to 4.33% respectively, when it was reported to the dry matter.

The limits presented by specific literature regarding the fat content in mulberry leaves are 2.85- 6.07% (Pop, 1967).

The crude cellulose was in average 5.31% in fresh leaves, 17.91±0.434%, respectively when in was reported to DM. Throughout the research, for a month, the crude cellulose increased with 2.29 percentage points, from 17.02% to 19.31%, respectively. According to the data from the specialized literature, in the common Mulberry the weight of the raw cellulose ranges between 12.33-14.38%, while in the different varieties selected oscillates between 10.43-13.70% (Craiciu, 1966). In the vegetation period of the mulberry the content in raw cellulose from the leaves increases from 14.47% to 21.16% (Pop, 1967). Increased cellulose content causes aging of the worm leaf, which becomes harder and harsher, therefore harder to consume by, which is why those varieties whose leaves have less cellulose content are considered more valuable.

Nitrogen free extract represented in average 43.27±0.418% from the dry matter of the mulberry leaves; the average values decreased from the first determination to the third, from 44.17% to 41.95%, then was an increasing to the fourth determination, being 43.89%, decreasing to the last analyses to 42.64%.

Table 1

The chemical composition evolution of the Eforie variety mulberry tree leaves during the silkworm larvae growth (%)

Ages	Water	DM	CP		EE		CF		NFE		Ash	
			F*	DM**	F*	DM**	F*	DM**	F*	DM**	F*	DM**
I	71.86	28.14	6.23	22.14	0.85	3.02	4.79	17.02	12.43	44.17	3.84	13.65
II	71.98	28.02	6.21	22.16	0.88	3.14	4.76	16.99	12.24	43.68	3.93	14.03
III	70.68	29.32	6.41	21.86	1.17	3.99	5.26	17.94	12.30	41.95	4.18	14.26
IV	69.53	30.47	6.00	19.69	1.22	4.00	5.58	18.31	13.37	43.89	4.30	14.11
V	68.15	31.85	6.06	19.03	1.38	4.33	6.15	19.31	13.58	42.64	4.68	14.69
$\overline{X}$	70.44	29.56	6.18	20.98	1.10	3.70	5.31	17.88	12.78	43.29	4.19	14.15
$s_{\overline{x}}$	-	0.725	-	0.670	-	0.260	-	0.434	-	0.418	-	0.169
Cv%	-	5.486	-	7.143	-	15.700	-	5.412	-	2.163	-	2.667

* fresh leaves; ** dry matter

The ash represented in average 4.19% in the fresh leaves and 14.15±0.169% from dry matter. The minerals from the mulberry leaves throughout the research registered a continuous increase from analyse to another. The average values varied from 3.84% to 4.68% to fresh leaves and from 13.65% to 14.69% from dry matter. An exception was registered to the third determination which had a higher value than the fourth one. The increasing in mineral content from mulberry leaves throughout the research was 1.04%. The values regarding the mineral substances, offered by the specialized literature, ranges between: 9.13-17.38% (Pop, 1967), 11.52-12.80% (Matei, 1995) and 8.7-13.15% (Bura *et al.*, 1995).

Knowing the raw chemical composition of the mulberry leaf, using the specific calculation equations, it was possible to assess the nutritional value of the mulberry leaf based on its content of raw energy, which was, on average, over the entire studied period, of 1245 Kcal/kg, in fresh leaf, respectively 4213 Kcal/kg, in the dry matter (tab. 2).

Table 2

Raw average energy of Mulberry leaf

Specification	%		Caloric equivalent	Kcal/100g		Kcal/100g	
	*	**		*	**	*	**
CP	6.18	20.98	5.72	35.35	120.01	353.5	1200.1
EE	1.10	3.70	9.50	10.45	35.15	104.5	351.5
CF	5.31	17.88	4.79	25.43	85.65	254.3	856.5
NEF	12.78	43.29	4.17	53.29	180.52	532.9	1805.2
						1245	**4213**

By recording the quantities of the worm leaf administered, the non-consumed and excreted residues and also determining their chemical composition (tab. 3), its digestibility coefficients could subsequently be calculated (tab. 4) and also the content of digestible substances in the leaf (tab. 5).

Table 3

Data needed to calculate digestibility coefficients

Specification	The larvae age	Quantity (g)	Chemical composition (%)					
			DM	CP	EE	CF	NEF	Ash
Leaves	I	15.5	28.14	6.23	0.85	4.79	12.43	3.84
	II	26	28.02	6.21	0.88	4.76	12.24	3.93
	III	77	29.32	6.41	1.17	5.26	12.3	4.18
	IV	242	30.47	6.00	1.22	5.58	13.37	4.30
	V	1000	31.85	6.06	1.38	6.15	13.58	4.68
Leftovers	I	5.12	60.97	14.67	2.07	14.41	22.49	7.33
	II	8.36	56.39	13.49	1.19	14.27	21.46	5.98
	III	23.63	60.09	12.42	2.15	15.94	24.85	4.73
	IV	66.84	58.17	12.17	1.75	15.78	23.63	4.84
	V	267.82	57.73	10.84	2.53	12.30	24.06	8.00
Excreta	I	0.15	71.40	17.00	5.33	2.93	31.87	14.27
	II	0.86	67.93	12.36	5.21	4.93	31.57	13.86
	III	3.93	62.62	15.66	2.76	6.45	25.92	11.83
	IV	20.12	63.92	10.95	2.17	11.55	28.06	11.19
	V	120.6	61.56	10.04	2.96	14.87	23.90	9.79

Following the complex phenomenon of digestion, nutrients are transformed into simple substances, which can thus be absorbed through the epithelium of the digestive tract, at different levels, thus being retained in the organism of silk larvae, representing practically the difference between the amount of substances ingested through food and the amount of appropriate substances found in droppings. Because not all the substances found in excrement are of dietary origin, some of them are of endogenous origin, which can be obtained by this difference, indicating only apparent digestibility. If you admit the fact that at *Bombyx mori* excretions are also found in their excrement, which complicates the establishment of the digestibility of nutrients in the wormwood even more accurately, the use of the approximate digestibility term seems to be more correct (Miranda and Takahashi, 1998; Rahmathulla *et al*., 2004; Rath *et al*., 2003; Sabhat *et al*., 2011; Tzenov, 1993).

During the whole period studied, the digestibility of the dried substance from the worm leaf had a digestibility of 57.21%. The highest digestibility was recorded in larvae of age I (91.36%), after which, by the end of the larval period, there was a decrease of 36.66 percent.

Digestibility of the dry substance from the worm leaf decreases from 71.07% in age I, to 39.99% (for male larvae), 48.26% (for female larvae) in age V

(Rath *et al.,* 2003). The worm leaf administered to the larvae of the fifth age has an approximate digestibility between 27.99% and 32.44% (Rahmathulla *et al.,* 2002).

Table 4

Digestibility coefficients of *Zefir* hybrid

The larvae age	Specification	DM	CP	EE	CF	NEF
I	Leaves	4.3617	0.9657	0.1318	0.7425	1.9267
	Leftovers	3.1217	0.7510	0.1062	0.7380	1.1513
	Ingest	1.2400	0.2147	0.0256	0.0045	0.7754
	Excreta	0.1071	0.0255	0.0080	0.0044	0.0478
	Digest	1.1329	0.1892	0.0176	0.0001	0.7276
	DC%	**91.36**	**88.12**	**68.75**	**2.22**	**93.84**
II	Leaves	7.2852	1.6146	0.2288	1.2376	3.1824
	Leftovers	4.7139	1.1280	0.0997	1.1931	1.7937
	Ingest	2.5713	0.4866	0.1291	0.0445	1.3887
	Excreta	0.5842	0.1063	0.0448	0.0424	0.2715
	Digest	1.9871	0.3803	0.0843	0.0021	1.1172
	DC%	**77.28**	**78.15**	**65.30**	**4.72**	**80.45**
III	Leaves	22.5764	4.9357	0.9009	4.0502	9.4710
	Leftovers	14.1995	2.9340	0.5090	3.7672	5.8728
	Ingest	8.3769	2.0017	0.3919	0.2830	3.5982
	Excreta	2.4611	0.6153	0.1086	0.2533	1.0187
	Digest	5.9158	1.3864	0.2833	0.0297	2.5795
	DC%	**70.62**	**69.26**	**72.29**	**10.49**	**71.69**
IV	Leaves	73.7374	14.5200	2.9524	13.5036	32.3554
	Leftovers	38.8785	8.1312	1.1720	10.5476	15.7950
	Ingest	34.8589	6.3888	1.7804	2.9560	16.5604
	Excreta	12.8604	2.2031	0.4362	2.3232	5.6448
	Digest	21.9985	4.1857	1.3442	0.6328	10.9156
	DC%	**63.11**	**65.52**	**75.50**	**21.41**	**65.91**
V	Leaves	318.5000	60.6000	13.8000	61.5000	135.8000
	Leftovers	154.6090	29.0360	6.7850	32.9360	64.4290
	Ingest	163.8910	31.5640	7.0150	28.5640	71.3710
	Excreta	74.2400	12.1040	3.5680	17.9340	28.8290
	Digest	89.6510	19.4600	3.4480	10.6300	42.5420
	DC%	**54.70**	**61.65**	**49.14**	**37.21**	**59.61**
I-V	Leaves	426.4607	82.6360	18.0139	81.0339	182.7355
	Leftovers	215.5226	41.9802	8.6719	49.1819	89.0418
	Ingest	210.9380	40.6560	9.3420	31.8520	93.6940
	Excreta	90.2528	15.0542	4.1656	20.5573	35.8118
	Digest	120.6850	25.6020	5.1760	11.2950	57.8820
	DC%	**57.21**	**62.97**	**55.41**	**35.46**	**61.78**

The raw protein had a digestibility coefficient for the entire studied period of 62.97%. The raw protein digestibility decreased progressively during the studied period, with 26.47%, respectively from 88.12%, in the first larval age, to 61.65%, in the last one. The high digestibility of age I could be explained by the rich content in amides, simple nitrogenous substances, which are found in the young leaf and which are digested much easier than the protein nitrogenous substances, which have the weight in the old leaf.

In the specialty literature, for raw leaf protein, the value of digestibility coefficients is between 69.21% and 78.92 (Borcescu, 1966), 60.06% and 74.69% (Petkov, 1980), 71.62% and 93.48% (Matei, 1995).

The raw fat from the worm leaf had the minimum digestibility value of 49.14%, in the larvae of the fifth age and maximum of 75.50%, in the larvae of the fourth age. The results of the digestibility tests regarding the raw fat in the worm leaf are generally inconclusive, as many of these can come from the intestine of the larvae and not from the leaf, which is why, we cannot speak of a determination of the digestibility of the fat itself but of the "ethereal extract", which also contains very large quantities of pigments. Thus, the big differences regarding the evolution of the digestibility of the raw fat during the studied period could be explained.

The values of the digestibility coefficient for raw fat are between 63.28% and 74.19% (Petkov, 1980).

During the whole larval period, the digestibility of the raw cellulose from the mulberry leaf was 35.46%, being very low in age I, 2.22%, after which it increased progressively, reaching the end of the period studied up to the value of 37.21%. This increase in the digestibility of raw cellulose, as the larvae grow older, is in line with the development of the enzymatic equipment in their digestive tract. Thus, if at age I, in the digestive tract of the larvae, the enzymes involved in the process of cellulose digestion are as non-existent, then they gradually increase, reaching the peak at age V, at which point the weight of raw cellulose from the worm leaf it is also bigger. This aspect, however, negatively influences the digestibility of the raw leaf protein, which during the same period, is experiencing a reduction.

At the beginning of the last century, some authors (Acqua, 1930 – cited by Doliş, 2008) found that the leaf cellulose passes undigested through the digestive tract of the larvae and later it was concluded that this substance has a digestibility of approx. 20% (Legay, 1955 - cited by Doliş, 2008). Recently, some authors state that in the first two ages, raw cellulose would not be digested, but only from the third (8%), its digestibility reaches 21.13% in the third period (Matei, 1995).

Unclaimed extractive substances from the worm leaf had a digestibility over the entire studied period of 61.78%, the digestibility coefficients registering decreasing values, from 93.84%, in the case of the larvae of age I, at 59.61%, in the case of those of fifth age.

Knowing the value of digestibility coefficients, it was possible to calculate the digestible content for each nutrient separately, then the content of digestible substances in the leaf, so when the report was made to the fresh leaf, 150.41 g of Total Digestive Substance/kg were obtained, and when the report was made on the dried substance from the leaf of the mulberry, its nutritional value was 509.09 g TDS/kg (tab. 5).

The determination of the digestible energy content of the worm leaf administered in the feed of silk larvae was made based on the relative digestible content of the nutrients contained in it, using the calorific equivalents recommended for monogastric animal species (tab. 6). In the case of the fresh leaf, the digestible energy content was 686.55 Kcal/kg, and in the case of the dry substance, 2323.93 Kcal/kg.

The calculation of the metabolic energy from the worm leaf administered in the feed of silk larvae was done by multiplying the digestible content of each nutrient with the energy equivalents recommended for monogastric (pig) animal species. Considering, however, the specificity of the silkworm's digestion, respectively the similarity with the digestion of the birds, for the estimation of the metabolic energy from the worm leaf, the energetic equivalents recommended for the birds were used (tab. 7).

The average content in metabolic energy from the fresh mulberry leaf was 636.35 Kcal/kg, when the recommended energy ratios for pigs were used, respectively 637.36 Kcal/kg, when the recommended coefficients for birds were used. In relation to the dry matter of the leaf, the content in metabolic energy was on average 2153.94 Kcal/kg, when the recommended energy coefficients for pigs were used, and 2156.78 Kcal/kg, when the recommended coefficients for birds were used.

Table 5

The nutritional value calculation of the mulberry leaves (g TDN/kg)

Specification	Raw chemical composition %		Digestibility coefficients	Digestive content %		g Total Digestive substance/kg	
	*	**		*	**	*	**
CP	6.18	20.98	62.97	3.89	13.21	38.92	132.11
EE	1.1	3.7	55.41	0.61	2.05	13.71	46.13
CF	5.31	17.88	35.46	1.88	6.34	18.83	63.40
NEF	12.78	43.29	61.78	7.90	26.74	78.95	267.45
Total						**150.41**	**509.09**

* Reported to the fresh leaves; ** reported to DM

Table 6

Digestive energy of Mulberry leaf

Specification	Digestive content %		Caloric equivalent (Kcal/g)	Kcal/kg	
	*	**		*	**
CP	3.89	13.21	5.78	224.84	763.54
EE	0.61	2.05	9.42	57.46	193.11
CF	1.88	6.34	4.40	82.72	278.96
NEF	7.90	26.74	4.07	321.53	1088.32
Total				**686.55**	**2323.93**

* Reported to the fresh leaves; ** reported to DM

In order to determine the efficiency of use of the nutrients in worm leaf by the silk larvae, except for the intake and digestion, which were calculated during the course of the digestibility tests, it was necessary to determine the average growth rate of the larvae and the mass of the silk shell. The data necessary for calculating the efficiency of the use of the worm leaf by the larvae, as well as the results obtained in this respect, were centralized in table 8.

Table 7

Metabolic energy of Mulberry leaf

Specification	Digestive content %		Caloric equivalent (Kcal/g)		Kcal/kg			
	*	**			*		**	
			swine	birds	swine	birds	swine	birds
CP	3.89	13.21	5.01	4.26	194.89	165.71	661.82	562.75
EE	0.61	2.05	8.93	9.50	54.47	57.95	183.07	194.75
CF	1.88	6.34	3.44	4.23	64.67	79.52	218.10	268.18
NEF	7.90	26.74	4.08	4.23	322.32	334.17	1090.99	1131.10
					636.35	**637.36**	**2153.97**	**2156.78**

* Reported to the fresh leaves; ** reported to DM

Table 8

Efficiency of using Mulberry leaf by *Bombix mori* Zefir larvae hybrid

Average body mass gained during the whole larvae stage (g)	Living larvae	5.166
	Dry matter	0.918
Silky shell mass (g Dry Matter)		0.401
Dry Matter of ingested leaf (g)		4.219
Dry Matter of digested leaf (g)		2.414
Ingested Dry Matter/Body mass Dry Matter (g)		4.594
Dry matter ingested/ Body mass Dry Matter (g)		2.628
Dry matter ingested/Silky shell Dry Matter (g)		10.521
Dry matter digested/ Silky shell Dry Matter (g)		6.019
CEI body mass %		21.77
CED body mass %		38.05
CEI silky shell %		9.50
CED silky shell %		16.61

From the data of this table it is observed that in the case of the *Bombyx mori* Zefir larvae hybrid, for every gram of silk wrap is required 10.52 grams of dry matter ingested from the wormwood, respectively 6.02 grams of digested dry matter, resulting in an efficiency of conversion of silk intake (CEI) of 9.50%, respectively of digestion (CED) of 16.61%.

The data obtained from the experience performed, regarding the efficiency of the use of the mulberry leaf by the larvae of Bombyx mori, are comparable with those presented in the literature (Matei, 1995; Rahmathulla *et al.*, 2002; Rath *et al.*, 2003; Sarkar, 1993; Tzenov, 1993).

CONCLUSIONS

- Expressed to dry matter from the mulberry leaves, Eforie variety the average values were: CP - 20.98 ± 0.670%, EE - 3.70 ± 0.260%, CF- 17.91 ± 0.4.34%, NEF - 43.27 ± 0.418% and ash - 14.15 ± 0.260%.

- At once with vegetation advancement and implicitly during each growth period of silkworm larvae, the mulberry leaf ages and its quality from the chemical composition point of view is decreasing.

- During the 30 days of the research, was noticed a decreasing of the moisture with 3.71% and of the CP with 3.11% and in the same time an increasing of the CF with 2.29%.

- During the whole period studied, the digestibility of the dried substance from the worm leaf had a digestibility of 57.21%. The dry matter digestibility decreased with 36.66 %.

- Digestibility coefficients of the CP (62.97%) and of the NFE (61.78%) from the mulberry leaves decreased during the study with 26.47%, and 34.23%, respectively.

The CF digestibility, very low at the beginning (2.22%), increased progressively till the fifth larval stage when it was 37.21%.

Nutritional value of the mulberry leaves was 509 g TDN/ kg DM.

Throughout the studied period, the gross enrichment of the worm leaf was on average 4213 Kcal/kg, in the dry substance

In the leaf, the content of digestible energy was, in the case of dry matter, 2324 Kcal/kg.

In relation to the dry matter of the leaf, the content in metabolic energy was on average 2154-2157 Kcal/kg.

In the case of the Zefir hybrid, for each gram of silk wrap, 10.52 grams of dry matter ingested from the mulberry tree are required, respectively 6.02 grams of digested dry substance, resulting an efficiency of conversion of ingestion (CEI) into silk of 9.50%, respectively of the digestion (CEI) of 16.61%

REFERENCES

1. **Borcescu A., 1966** - *Hrănirea viermilor de mătase în creşterile de vară şi toamnă*. Sericicultura, nr. 3, p. 6-9.
2. **Borcescu A., 1966** - *Particularitățile digestiei la viermele de mătase*, Sericicultura, no. 1, pp. 25-30.
3. **Bura M.; Acatincăi S.; Pădeanu I., 1995** - *Viermii de mătase - biologie şi creştere*, Ed. Helicon, Timişoara.
4. **Craiciu E., 1966** – *Contribuții la identificarea şi descrierea soiurilor de dud din Republica Socialistă România*. Lucrări ştiințifice S.C.A.S., vol. VI, p. 245-285, Redacția Revistelor Agricole, Bucureşti.
5. **Doliş M., 2008** - *Sericicultură*. Ed. Alfa, Iaşi.
6. **Halga P.; Pop I.M.; Bădeliță C.; Popa V.; Man D., 2005** – N*utriție şi alimentație animală*. Ed. Alfa, Iaşi.
7. **Ifrim S., 1998** – *Mătasea naturală*, Ed. Ceres, Bucureşti.

8. Lazăr S., Vornicu O.C., 2013 - *Bazele biologice şi tehnice ale producției sericicole*. Ed. Ion Ionescu de la Brad, Iaşi.

9. Matei A., 1995 – *Determinarea valorii nutritive a principalelor soiuri şi hibrizi de dud cu utilizare în creşterea industrială a lui Bombyx mori*. Rezumat Teză de doctorat, U.Ş.A. Bucureşti.

10. **Mărghitaş L. A., 1995** – *Creşterea viermilor de mătase*, Ed. Ceres, Bucureşti.

11. **Miranda J.E., Takahashi R., 1998** - *Efficiency of food utilization by the silkworm, Bombyx mori L. (Lepidoptera: Bombycidae) feed on artificial diets*. Sericologia, 38, no. 4, pp. 601-610.

12. **Pătruică S., 2013** - *Apicultură şi Sericicultură*, Ed. EUROBIT, Timişoara.

13. **Petkov N., 1980** - *Studies on the utilization of mulberry leaves of some varieties at different norms and seasons of silkworm feeding. II Expenditure of mulberry leaves per unit of production, and their repayment by spring feeding of silkworms.* Sericologia, 20, no. 1-2, p. 32.

14. **Pop E. C., 1967** – *Compoziția chimică a frunzelor de dud în diferite perioade şi consumabilitatea ei*. Sericicultura, nr. 4, p. 12-18.

15. **Rahmathulla V.K., Suresh H.M., Mathur V.B., Geetha Devi, R.G., 2002** - *Feed conversion efficiency of elite bivoltine CSR hibrids silkworm Bombyx mori L. Reared under different environ mintal conditions*. Sericologia, 42, no. 2, pp. 197-203.

16. **Rahmathulla V.K., Suresh H.M., Mathur V.B., Geetha Devi, R.G., 2004** - *Growth and Dietary Efficiency of Mulberry Silkworm (Bombyx mori L.) Under Various Nutritional and Environmental Stress Conditions*. Philippine Journal of Science 133, no. 1, pp. 39-43.

17. **Rath S.S., Narain R., Prasad B.C., Roy G.C., Sinha B.R.R.P., 2003** - *Food allocation budgeting in tropical tasar, Antheraea mylitta feed on Terminalia tomentosa*. Sericologia, 43, no. 4, pp. 557-564.

18. **Sabhat A., Malik M.A., Malik F.A., Sofi A.M., Mir M.R., 2011** - *Nutritional efficiency of selected silkworm breeds of Bombyx mori L. reared on different varieties of mulberry under temperate climate of Kashmir*. African Journal of Agricultural Research, 6, no.1, pp. 120-126.

19. **Sarkar A., 1993** - *Effect of feeding different races of silkworm (Bombyx mori L.) with Mulberry (Morus indica L.) leaves varying in ploidy level*. Sericologia, 33, no. 1, pp. 25-34.

20. **Tzenov P., 1993** - *Study on the food utilization in genetic sex- limited breeds for egg and larval traits of the silk worm, Bombyx mori L., at moderate, reduced and excess feeding amounts.* Sericologia, 33, no. 2, pp. 247-256.