RESEARCH REGARDING THE CONSUMPTION OF MULBERRY LEAVES IN RELATION TO *BOMBYX MORI* LARVAE'S AGE

STUDIU PRIVIND CONSUMABILITATEA FRUNZEI DE DUD ÎN RAPORT CU VÂRSTA LARVELOR DE *BOMBYX MORI*

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Abstract. *During the growth of silk larvae series on summertime, alternated with the development of several experiences regarding the nutritional value of mulberry leaves obtained from some varieties. There were also studied the dynamics of leaf consumption by Bombyx mori larvae. Data regarding this fact shown that if during age I, the average value of consumption coefficient was 24.72±0.88%, which it has been increased progressively while the larvae grew (during age V this coefficient was 51.57±0.42%). During the whole larvae period, the consumption coefficient registered an average value of 51.07±0.45%.*
Key words: leaf, Mulberry, larvae, consumption, food

Rezumat. *Pe parcursul creşterii unei serii de larve de mătase pe timp de vară, în paralel cu derularea unor experienţe privind determinarea valorii nutritive a frunzei de dud provenită de la mai multe soiuri, s-a studiat şi dinamica consumabilităţii frunzei de către larvele de Bombyx mori de-a lungul perioadei larvare. Rezultatele obţinute au arătat că, dacă în vârsta I valoarea medie a coeficienţilor de consumabilitate a fost de 24,72±0,88%, ulterior aceasta a crescut progresiv, odată cu înaintarea în vârstă a larvelor, ajungând să se dubleze la nivelul vârstei a V-a (51,57±0,42%). Pe întreaga perioadă larvară, coeficienţii de consumabilitate au avut o valoare medie de 51,07±0,45%.*
Cuvinte cheie: frunze, dud, larve, consum, hrană

INTRODUCTION

Bombyx mori is a monofagic insect which means that their larvae consume exclusively mulberry leaves due to several special substances found in their leaves (β-γ-hexanol and α-β-hexanol) and perceived through the maxillary papillae (Doliş, 2008; Lazăr and Vornicu, 2013; Matei, 1995; Pătruică, 2013).

Using the mandible, larvae drill the leaves into wholes with rounded edges and size that depend on age of larvae and also on leaf's maturity (Ifrim, 1998; Matei, 1995; Mărghitaş, 1995).

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If the larvae have a fresh leaf, they register a continuous consumption, which is influenced by various internal factors as age, breed, sex, health of larvae etc. and also external factors as temperature and humidity of the environment, number of meals, administration method, quality of leaves etc.

During age I, larvae consume only the soft part of leaves, which form the leaves shell, without drilling it because the mouth appendix are not highly developed and as a result in the first part of life the food remains unconsumed on feeding bed.

Starting age III, larvae attack the leaf from the edge, consuming also the thinner ribs drilling the leaf with bigger wholes; through this act the larvae reaches the full consumption of mulberry leaves the only residue being represented by the stalk and the main ribs.

The food consumption is different during every age but there is a reduction at the start of it and also at the end and a growth in the middle of each one.

Maintaining the normal temperature and humidity of environment regarding the best larvae growth, positively influence their nutrition behavior, the food being attacked and consumed with a higher intensity.

The physical condition and quality of leaf have a highly importance regarding the way that the leaf is attacked and consumed by the larvae, which means that when the food is given in several times or as sprouts the larvae show a more intense consumption due to freshness and softness (Borcescu, 1966; Petkov,1980). The young leaves are consumed in a shorter period of time and in bigger quantities (Matei, 1995; Rahmathulla *et al*., 2002; Rath *et al.*, 2003; Sarkar, 1993; Tzenov, 1993).

Also the intensity of food gripping is influenced by the chemical quality of mulberry leaf, different regarding the breed of it (Craiciu, 1966; Bura *et al.,* 1995; Matei, 1995; Pop, 1967).

This paper wished to add a small contribution to the study of factors that influence the consumption of mulberry leaf, more precisely to emphasize the dynamic of leaves consumption in relation to larvae's age.

MATERIAL AND METHOD

The biological material used within the experiences was represented by the mulberry leaf from three different varieties (Eforie, Kokuso 21 and Selected Hybrid) and four types of *Bombyx mori* hybrids (Băneasa Super, Zefir, Record, Triumf).

Regarding the experiences there were used three groups of 600 larvae, each one of it receiving leaves from a variety indicated above. Within each batch, larvae were divided into four subgroups of 150 individuals of every *Bombyx mori* hybrid. Regarding an easier way to watch every subgroup, each number of 150 larvae was divided into three batches of 50 individuals which were raised on paper trays sized by age and larvae's dimensions; also there was created a spare groups of 50 larvae raised in isolation but in the same conditions, which served for replacing the dead larvae from experimental subgroups.

The larvae growth took place in August, inside an air-conditioned room, following all microclimate factors; every subgroup received the same leaf quantities

from the same variety of mulberry leaf, from which we have collected samples in advance to determine the humidity and dry substance level (Halga *et al.,* 2005).

Every day and at the same time from each subgroup we have collected, weighted and registered the unconsumed residue of mulberry leaves. The obtained quantities from each subgroup were summed and divided into three batches to find out the average quantity of unconsumed residue produced by 50 larvae.

The appreciation of mulberry leaf expendability was made through expendability coefficients (EC%), calculated by following formula: CC (%) = (ingested quantity in grams/leaf given in grams) x 100. (Ingested food = Administrated food – Residues).

In every subgroup, the expendability coefficients of mulberry leaf were calculated for each larvae age.

Since, between the leaf humidity when administrated and the unconsumed residue, which remains on the feeding bed from a day to another, there are differences determined by the dehydration process, the expendability coefficients were calculated based on dry substance from leaves and unconsumed residue of them (Miranda and Takahashi, 1998; Rahmathulla *et al*., 2004; Rath *et al*., 2003; Sabhat *et al*., 2011; Tzenov, 1993).

Data obtained were statistically processed.

RESULTS AND DISCUSSIONS

The quantities of administrated leaf and unconsumed residue from each group and also subgroup according to larvae age were centralized in table 1.

Table 1

The administrated quantities of mulberry leaf and unconsumed residue

Specification		**Administrated leaf (g)**				
		15.5	26	77	242	1000
Mulberry variety	**Larvae age**	I	II	III	IV	V
	Hybrid B. mori	**Residue (g)**				
Eforie	Băneasa Super	5.11	8.01	22.65	65.94	269.01
	Zefir	5.12	8.36	23.63	66.84	267.82
	Record	5.28	8.33	23.04	66.10	266.00
	Triumf	5.3	9.01	24.01	65.15	264.12
Kokuso 21	Băneasa Super	4.98	8.01	23.82	66.94	269.01
	Zefir	5.01	8.78	24.01	68.17	269.41
	Record	5.23	8.56	24.00	68.00	270.21
	Triumf	5.01	8.22	23.14	67.93	269.02
Selected Hybrid	Băneasa Super	5.29	8.76	23.55	66.02	267.00
	Zefir	4.89	8.01	24.13	66.87	268.22
	Record	5.32	8.42	23.86	67.18	266.30
	Triumf	5.02	7.94	23.83	67.00	267.51

Dry substance determination (DS) of leaves and residue is centralized in table 2; this data served for establishing the leaf consumption respectively the ingested quantity (table 3).

Due to specific calculations we could determine the expendability coefficients (EC%) for every larvae age (table 4).

Table 2

Dry substance content of mulberry leaf and unconsumed residue

Larvae age			I	II	III	IV	V
Mulberry variety	**Hybrid *B. mori***						
Mulberry leaf							
Eforie		%	28.14	28.02	29.32	30.47	31.85
		g	436.17	728.52	2257.64	7373.74	31850.00
Kokuso 21		%	27.91	28.34	29.59	29.87	31.14
		g	432.61	736.84	2278.43	7228.54	31140.00
Selected Hybrid		%	28.04	28.25	28.97	29.87	31.76
		g	434.62	734.50	2230.69	7228.54	31760.00
Residue							
Eforie	Băneasa Super	%	62.58	58.85	61.54	56.49	57.92
		g	319.78	471.39	1393.88	3724.95	15581.06
	Zefir	%	60.97	56.39	60.09	58.17	57.73
		g	312.17	471.42	1419.93	3888.08	15461.25
	Record	%	62.67	56.76	61.03	56.27	56.00
		g	330.90	472.81	1406.13	3719.45	14896.00
	Triumf	%	63.61	59.16	58.81	58.06	58.56
		g	337.13	533.03	1412.03	3782.61	15466.87
Kokuso 21	Băneasa Super	%	67.99	62.18	62.07	60.01	59.09
		g	338.59	498.06	1478.51	4017.07	15895.80
	Zefir	%	66.90	60.51	61.73	59.06	58.87
		g	335.17	531.28	1482.14	4026.12	15860.17
	Record	%	65.56	59.89	60.02	55.31	56.36
		g	342.88	512.66	1440.48	3761.08	15229.04
	Triumf	%	63.82	60.02	58.39	59.53	56.73
		g	319.74	493.36	1351.14	4043.87	15261.50
Selected Hybrid	Băneasa Super	%	62.78	59.94	59.94	56.21	56.10
		g	332.11	525.07	1411.59	3710.98	14978.70
	Zefir	%	63.21	58.41	60.00	58.26	56.12
		g	309.10	467.86	1447.80	3895.85	15052.51
	Record	%	63.96	57.21	60.14	56.33	55.78
		g	340.27	481.71	1434.94	3784.25	14854.21
	Triumf	%	61.12	57.65	59.66	54.95	56.00
		g	306.82	457.74	1421.70	3681.65	14980.56

Analyzing these coefficients there is obvious that as the larvae grow also the the mulberry leaf expendability increases. So if in age I. the average value of expendability coefficients had a value of 24.72±0.88. In age V they were 51.57±0.42, which means that the registered growth was more than double (26.85%).

Also, it can be observed that if in the first two larvae ages the variability of expendability coefficients registered on subgroup levels was fairly high (10.90-12.38%). Subsequently it was reduced under the level of 4.44%. That indicates that the subgroups were homogenous from this point of view.

Table 3

Mulberry leaf quantity consumed by *Bombyx mori* (g DS)

Larvae age		I	II	III	IV	V
Mulberry variety	**Hybrid *B. mori***					
Eforie	Băneasa Super	116.39	257.13	863.76	3648.79	16268.94
	Zefir	124.00	257.10	837.71	3485.66	16388.75
	Record	105.27	255.71	851.51	3654.29	16954.00
	Triumf	99.04	195.49	845.61	3591.13	16383.13
Kokuso 21	Băneasa Super	94.02	238.78	799.92	3211.47	15244.20
	Zefir	97.44	205.56	796.29	3202.42	15279.83
	Record	89.73	224.18	837.95	3467.46	15910.96
	Triumf	112.87	243.48	927.29	3184.67	15878.50
Selected Hybrid	Băneasa Super	102.51	209.43	819.10	3517.56	16781.30
	Zefir	125.52	266.64	782.89	3332.69	16707.49
	Record	94.35	252.79	795.75	3444.29	16905.79
	Triumf	127.80	276.76	808.99	3546.89	16779.44

Table 4

Expendability coefficients registered at mulberry leaf (%)

Larvae age		I	II	III	IV	V	I-V
Mulberry variety	**Hybrid *B. mori***						
Eforie	Băneasa Super	26.68	35.29	38.26	49.48	51.08	50.39
	Zefir	28.43	35.29	37.11	47.27	51.46	50.54
	Record	24.14	35.10	37.72	49.56	53.23	48.83
	Triumf	22.71	26.83	37.46	48.70	51.44	50.49
Kokuso 21	Băneasa Super	21.73	32.41	35.11	44.43	48.95	53.16
	Zefir	22.52	27.90	34.95	44.30	49.07	53.17
	Record	20.74	30.42	36.78	47.97	51.09	50.90
	Triumf	26.09	33.04	40.70	44.06	50.99	51.34
Selected Hybrid	Băneasa Super	23.59	28.51	36.72	48.66	52.84	49.44
	Zefir	28.88	36.30	35.10	46.10	52.61	49.95
	Record	21.71	34.42	35.67	47.65	53.23	49.30
	Triumf	29.40	37.68	36.27	49.07	52.83	49.18
$\overline{X}$		24.72	32.77	36.82	47.27	51.57	51.07
$S_{\overline{x}}$		0.88	1.03	0.47	0.59	0.42	0.45
V%		12.38	10.90	4.44	4.35	2.85	3.08
MIN		20.74	26.83	34.95	44.06	48.95	48.83
MAX		29.40	37.68	40.70	49.56	53.23	53.17

In terms of expendability coefficients dynamics, during the larvae period, there was registered an increase of 8.05% from age I to age II, a plus of 4.05% from age II to age III, a plus of 10.45% from age III to age IV and a plus of 4.30% from age IV to age V.

Depending on subgroups and on combinations leaf-larvae, the highest values of expendability coefficients were registered at: Selected Hybrid – Triumf combination, age I (29.40%) and age II (37.68%), Kokuso 21-Triumf age III

(40.70%), Eforie-Record age IV (49.56%) and Selected Hybrid – Record, age V (53.23%).

At the opposite pole, the lowest values of expendability coefficients registered the following combinations: Kokuso 21-Record, age I (20.74%), Eforie-Triumf age II (26.83%), Kokuso 21-Zefir, age III (34.95%), Kokuso 21-Triumf, age III (44.06%) and Kokuso 21-Băneasa Super, age V (40.70%).

Analyzing data there was revealed that there is no specific constancy regarding the hierarchy of obtained values of combinations mulberry variety – larvae.

During the whole larvae period, the expendability coefficients had an average value of 51.07±0.45%.

The highest expendability percent (53.17%) was registered at Kokuso 21 mulberry variety, which was administrated to *Bombyx mori* and the lowest expendability percent (48.83%) was observed in Eforie mulberry variety administrated to Record hybrid.

CONCLUSIONS

1. On the growth larvae period, the average value of expendability coefficients increased from 24.72±0.88% (age I) to 51.57±0.42% (age V), indicating that the value practically doubled;

2. There is no specific constancy regarding the hierarchy of expendability coefficient obtained during the combination of mulberry varieties and larvae hybrids in experiences.

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