

Some Nutritional Studies on Some Bulgarian Silkworm (*Bombyx mori* L.) Hybrids Reared in Northern Greece

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In the spring silkworm rearing period of year 1998, some nutritional aspects were studied in the Agricultural Research Station of the Komotini town in Greece, to investigate the feeding behaviour of some Bulgarian silkworm hybrids, suitable for spring rearing, during the fourth and fifth instar under the local climatic conditions. The silkworms were fed by locally cultivated Japanese Kinriu mulberry (*Morus alba* L.) variety leaves. Eight Bulgarian hybrids had been used, namely Vratza-53×Vratza-52, Ukraine-20×Vratza-53, Super 1×Hessa 2, Merefa 2×Vratza 35, as well as their reciprocal crosses. The studies showed out a remarkably higher feed intake and feed utilization by the hybrids Hessa 2×Super-1, Merefa 2×Vratza 35 and Vratza-52×Vratza-53. The same hybrids showed an efficient food utilization by means of daily growth, cocoon shell ratio and raw silk output. In terms of food to silk conversion efficiency Hessa 2×Super-1 hybrid gave the best results. Larval stage duration for fourth and fifth instar was not affected by feed intake and utilization. All hybrids showed a good adaptation to the local environment and their feeding performance was equal to the international existing standards. All calculated parameters were found to be around the mean values of other up to date presented results and thus considered as acceptable for the needs of the local production.

Key words : Silkworm feeding, *Bombyx mori* L., Silkworm hybrids

Introduction

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All northern Greece, but especially the Thraki area, located in the upper northeast part of the country, has a very long sericultural tradition. This area today represents the only part of Greece where sericultural activities still exist. Although being one of the traditional cocoon producers until the end of the 1960s, Greece, like other European countries, entered to a progressive declining of this activity during the last thirty years. However recently appeared an increased interest of the domestic and international market for silk products. This fact combined to the deep-rooted national traditions, the favourable climatic and social conditions and also the support of the activity through EEC, gives a hope of reactivation of sericulture in Greece. Until now silkworm rearing in this area was carried out based on the traditional skills of the silkworm farmers and no scientific efforts had been invested in order to improve its efficiency. Recently the National Agricultural Research Foundation of Greece, through the Komotini Agricultural Research station, which is located into the sericultural area of Thraki, decided to get involved into the sericulture field, creating international relations and scientific exchanges with all the todays active sericultural countries and establishing a scientific support to the silkworm farmers of the area. Part of this effort represents this work. One of the main ways of intensifying cocoon and silk production, both on national and international level, is the use of highly productive silkworm (*Bombyx mori* L.) hybrids, (Petkov, 1984, 1995; Hirata, 1985; Braslavskii, 1987; Natcheva, 1990; Gupta *et al.*, 1992; Brasla and Matei, 1992). The different breeds and hybrids of the silkworm vary in their growth parameters and also show characteristic variations in their food intake and utilization efficiencies (Tzenov, 1995, 1996). These differences and variations, for many silkworm breeds and hybrids, and for many environments have been studied by many authors of different origin. Most of the studies deal with the intake and utilization of the food during the fifth larval instar

under the specific environment of each trial and investigation give some guidelines for controlled feeding during this stage (Tzenov *et al.*, 1997). Some other authors though have shown that controlled and restricted feeding during this stage decreases significantly some very important production parameters, compared to the *ad-libitum* feeding during the same stage (Tzenov, 1993). Of course the amount of food consumed during the fifth larval instar of the silkworm represents and the highest and the most economically important part of the totally consumed food (Tzenov and Petkov, 1993, 1995), and this is the reason why most of the research held, deals with this part. This work taking in consideration of all of the above facts, tried to investigate some nutritional aspects of the mentioned Bulgarian silkworm hybrids, under the specific environment of the Thraki area in Greece during a spring rearing.

Materials and Methods

Eight Bulgarian silkworm hybrids (direct and reciprocal crosses) were tested in the Agricultural Research Station of Komotini in Greece, a station situated in the main sericultural area of the country, during the spring rearing of year 1998. The eggs were put to incubation on April 20 and hatching occurred at the beginning of May. The rearing was carried out in the rearing facilities of the station and under natural not controlled conditions, except for the first two larval stages, where artificial heat was given during the night. The hybrids used for the trial were Vratza-53 × Vratza-52, Ukraine-20 × Vratza-53, Hessa 2 × Super 1, Meref 2 × Vratza 35 and their reciprocal crosses. The subject of the study was the investigation of some parameters of their feeding behavior in the fourth and fifth instar and under *ad-libitum* feeding scheme. These parameters were investigated in relation to their growth and final silk output, under the conditions of the Research Station area, which represents the average conditions of the main Greek sericultural area and geographic and climatic data whos are given in Table 1. The considered parameters were: dry matter intake and utilization in relation to silkworm fourth and fifth larval stage duration and also raw cocoon yield per box of eggs and average cocoon shell ratio. All hybrids were reared on 0.6 m² experimental shelves, in four replications, each consisting of 200 silkworms. Accurate data were taken for both larval stage and moth start and duration. The silkworms were fed by locally cultivated, in the Komotini Research Station field, Japanese Kinriu mulberry (*Morus alba* L.) variety well matured leaves. Three adequate meals were given daily, providing an *ad-libitum* feeding to the silkworm. Sometimes an additional amount of the lives were provided to

Table 1. Meteorological data of Komotini Agricultural Research Station during the silkworm rearing period (May 1-May 28)

Year	Air temp. 2 m above ground			Relative air Humidity %
	Average	Maximum	Minimum	
1994	18.6	26.4	10.6	75.5
1995	17.8	25.8	9.4	74.3
1996	18.6	27.1	9.8	74.8
1997	18.22	25.5	10.8	76.5
1998	17.6	25.9	9.2	73.1
5 year mean	18.16	26.14	9.96	74.84

Place: Komotini, Greece. Latitude 41° 05', Longitude 25° 20', Altitude 37 m

Source: Ministry of Agriculture, Komotini Division

the silkworms consuming a large quantity. A sample of the daily collected leaf amount was directed for dry matter content estimation according to the international standards for analysis (Official methods of analysis, Association of official Agricultural chemists). Leaf remaining and silkworm feces were collected every other day and their weight and dry matter content were estimated as well. The utilized amount of the ingested dry matter was estimated as the difference between the supplied and remained in the litter and fecal dry matter, by the equation $UDM = SDM - (RDM + FDM)$, where:

UDM = utilized dry matter.

SDM = supplied dry matter.

RDM = remained dry matter.

FDM = fecal dry matter.

The feeding period of the stages two instar, including the days of the early mounting silkworms had a duration of 18 days. Silkworm rearing and mean value calculations had been carried out according to the methods adopted in Bulgaria, (Petkov *et al.*, 1989). The experimental design was the randomized block design. Control was the hybrid Hessa 2 × Super 1, which is considered to be the most popular and the most widely used in Bulgaria. The obtained data, by means of the four replication mean, were statistically analyzed by the analysis of variance (Snedecor and Cochran, 1967, Mokreva, 1988).

Results and Discussion

Table 2 is given for a detailed description about the dry matter contents of the used mulberry leaves for the feeding of the silkworm used in the experimentation. From

Table 2. Dry matter content of the daily collected mulberry leaves

Experimentation Day	Mulberry leaf sample fresh weight, grams	Mulberry leaf sample dry weight, grams	Mulberry leaf sample Dry matter content %
1	201.7	55.6	27.56
2	188.6	48.3	25.60
3	248.5	65.4	26.31
4	247.3	61.2	24.74
5	204.3	56.6	27.70
6	219.4	67.2	30.62
7	210.0	66.8	31.80
8	209.6	63.5	30.29
9	217.6	65.4	30.05
10	292.4	85.7	29.30
11	216.0	71.2	32.96
12	210.3	63.4	30.14
13	213.3	66.9	31.36
14	225.8	68.6	30.38
15	218.6	64.9	29.68
16	231.2	69.8	30.19
17	211.6	64.7	30.57
18	217.7	66.2	30.40

these data it is obvious that the used leaves were of a high dry matter content, the lower value being 24.74%, observed in the early stages of the experimentation, and the higher reaching 32.96% and observed around the middle of the fifth instar feeding. These values come in reasonable relation to the feeding leaf selection according to the needs of each silkworm instar, the lower dry matter content fed to the fourth and the higher to the fifth instar. The observed and investigated feeding and production parameters are given in Table 3. From this table it is observed that the highest amount of fresh mulberry leaves was consumed by the Hessa 2 × Super 1 hybrid, 5.347 Kg, against 4.674 Kg, quantity which was consumed by Vratza 35 × Meref 2 hybrid. No statistically significant differences were observed for this parameter though. These values come in relation to the total dry matter utilized by the silkworm, the highest value again observed for the Hessa 2 × Super 1 hybrid, which appeared to have the highest dry matter utilization efficiency, 1.304 g per replication and 6.52 g per silkworm. The lowest value for this parameter was observed in Vratza 53 × Ukraine 20 hybrid, 810 and 4.05 g respectively per replication and silkworm, the values being significantly different for $P \leq 5\%$. The same statistical significance for these parameters

was observed between the control Hessa 2 × Super 1 hybrid and the Vratza 53 × Vratza 52 and the Vratza 53 × Ukraine 20 hybrids, showing a dry matter consumption of 890 and 4.45, 810 and 4.05 g per replication and individual silkworm respectively. The Vratza 53 × Vratza 52 hybrid gave the highest number of total first quality cocoons harvested per replication, 190 cocoons, against the lowest value of 179 cocoons of the Meref 2 × Vratza 35 hybrid. There were no statistically significant differences observed between the values of this parameter as well. The mean values obtained for larval stage duration for the observed instars, a biological trait with a marked contribution to the total food consumption and the final formation of cocoon yield and silk output, show that in this case Vratza 52 × Vratza 53 hybrid had the highest duration, 394 hrs, and as described consumed relatively high amounts of dry matter. In contrast to that, this hybrid gave very low performance in fresh cocoon weight, fresh cocoon shell weight and total cocoon yield per box, the values having a statistically significant difference to the control, and appeared to be a very bad food converter to cocoon yields. The fresh cocoon weight obtained the highest value in the Hessa 2 × Super 1 hybrid, 1.785 g, something which comes in correlation to the high dry matter utilization of this hybrid. The lowest value for this trait was given by the Vratza 52 × Vratza 53, 1.457 g respectively, the difference being statistically significant for $P \leq 5\%$. The highest mean fresh cocoon shell weight was observed in Vratza 53 × Ukraine 20 hybrid, 0.486 g and the only statistically significant difference for this trait was observed between the control and the Vratza 52 × Vratza 53 hybrid, which showed a value of 0.412 g. In the case of the cocoon shell ratio the highest value was observed in the Vratza 53 × Ukraine 20 hybrid, giving an estimate of 29.36%. The lowest value for this case was observed in the Hessa 2 × Super 1 hybrid, 26.49% respectively, but no statistically significant differences had been observed for this parameter. The values obtained for the above parameters of the Bulgarian silkworm hybrids Super 1 × Hessa 2, Vratza 35 × Meref 2 and the reciprocal crosses, reared under the Greek Station area conditions, appear in full agreement with previous investigations, (Marovic *et al.*, 1991). In the case of the fresh cocoon yield per box of silkworm eggs, estimated by the mean fresh cocoon weight multiplied by the approximate egg number in a box, thus 20.000, the results come in accordance to the observed fresh cocoon weight, the highest value observed in the Hessa 2 × Super 1 hybrid, reaching 35.70 Kg. The lowest estimate was observed in the Vratza 52 × Vratza 53 hybrid, reaching 29.14 Kg and representing the only statistically significant difference for this trait.

Table 3. Feed and dry matter supply and utilization

Silkworm hybrid	Amounts per 200 silk worm replication				Total feed dry matter utilized per silkworm 6=5/200	Average number of cocoons harvested per replication (total/4) 7	Fourth and fifth instar larval stage duration hours 8	Mean fresh cocoon weight grams 9	Mean fresh cocoon shell weight grams 10	Average fresh cocoon shell ratio % 11	Estimated Fresh Cocoon Yield Per box Kgs 12	
	Total fresh mulberry leaves supplied grams 1	Total dry matter utilized by silkworms 5=2-(3+4)	Mulberry leaf dry matter remained in litter grams 3	Fecal dry matter collected grams 4								
Vratza 53 × Vratza 52	4.685	1.283	157	236	890*	4.45*	192	389	1.652	0.455	27.54	33.04
Vratza 52 × Vratza 53	5.245	1.646	120	283	1.243	6.21	186	394	1.457*	0.412*	28.27	29.14*
Ukraine 20 × Vratza 53	4.683	1.372	131	264	977	4.88*	188	377	1.688	0.463	27.42	33.76
Vratza 53 × Ukraine 20	3.903	1.186	144	232	810*	4.05*	191	384	1.655	0.486	29.36	33.10
Hessa 2 × Super 1	5.347	1.678	151	223	1.304	6.52	190	380	1.785	0.473	26.49	35.70
Super 1 × Hessa 2	4.947	1.429	142	211	1.076	5.38	190	388	1.563	0.451	28.85	31.26
Merefa 2 × Vratza 35	4.793	1.490	164	192	1.134	5.67	181	371	1.692	0.478	28.25	33.84
Vratza 35 × Merefa 2	4.674	1.392	176	210	1.006	5.03	184	351*	1.533	0.407	26.54	30.66

*** Column 2 was calculated by daily dry matter calculation according to sample dry matter content.

* P ≤ 0.05

As it is concluded from the obtained in this work results, all the tested Bulgarian silkworm hybrids showed a very reasonable behavior under the experimentation conditions in northern Greece. Dry matter consumption and utilization appeared considerably high. Among them though Hessa 2 × Super 1, Merefata 2 × Vratza 35, and Vratza 52 × Vratza 53 appeared as the best food converters, giving the best performance in connection to the northern Greek climatic and rearing conditions. The above hybrids proved to be promising for rearing under the described conditions of northern Greece, where the Komotini Research Station is situated. The recorded and considered as most important parameters in this work, like dry matter utilization and conversion, larval stage duration, raw cocoon yield per 1 box of eggs and cocoon shell ratio, appear to be in the range of the up to date shown behaviour of these hybrids and above the generally acceptable limits.

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