

## Breeding of a New Non-Cocooning Silkworm Variety, Hachojam, Suitable for Autumn Rearing Season

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**A new non-cocooning silkworm variety, Hachojam, suitable for autumn rearing season is single cross F1 hybrid between Japanese race Jam 307 and Chinese race Jam 126. Jam 307, Japanese parent of the Hachojam, which is a source for non-cocooning process showed a high GCA (generation combining ability) in naked pupation rate and Jam 126, Chinese parent, showed a high GCA in pupation rate and single pupal weight. In the local adaptability test performed at 8 local areas in autumn of 1999 to 2000, the naked pupation rate and thin cocoon rate of Hachojam were 64.7% and 35.3%, respectively. The pupal weight calculated from 10,000 of the 3rd molted larvae was 24% heavier in Hachojam than the cocoon-producing, check variety Daesungjam.**

**Key words :** Non-cocooning silkworm, Hachojam, Breeding, Naked pupa, Combining ability

### Introduction

Because of economic importance for silk yarn, above all, an effort to breed new silkworm variety has been made for thousand years after first domestication. Today, several hundred varieties have been bred accordingly various interests and purposes (Lee and Kim, 2000, Sohn *et al.*, 1987; Kang *et al.*, 2001).

Recently, domestic silkworm, *Bombyx mori*, is attended to be used as an important host for the production of biologically active substances such as heterologous proteins

by baculovirus expression vector system (Choudary *et al.*, 1995; Maeda *et al.*, 1985), silkworm vegetable wasp and plant worm (Dongchunghacho) (Cho, 1999; Lee *et al.*, 2001), blood glucose-lowering material, and functional food materials (Lee and Kim, 2000). Silkworms offer a number of advantages over other insects. These include a larger body size, ease of handling, nonallergenic to human, and well-characterized genetics (Choudary *et al.*, 1995). Therefore, development of new breeds possessing functionality and special purpose is focused on the breeding of silkworm.

The effort to utilize pupae for the production of dongchunghacho as a biomaterial was problematic in terms of labor, because of cocoon removal and reincubation steps (Choi *et al.*, 1999). However, this problem would be possible to solve when naked pupa was produced (Nakano, 1951; Watanebe, 1959). Thus dongchunghacho research on one hand was to breed a non-cocooning variety, producing heavier pupae and requiring less labor.

Here, we report the development of the new non-cocooning variety, Hachojam, which was nominated in 2001 as a new recommended variety for autumn rearing season. The variety was bred developed through pure line test, combining ability test, and local adaptability and main productivity tests in Korea. In the present report, the major breeding schemes and important characteristics of Hachojam are described.

### Materials and Methods

A non-cocooning silkworm variety, Hachojam, in this study was bred by single cross method between Japanese race and Chinese race (Harada, 1961; Watanebe, 1959). Hachojam is a variety generated by single cross F1 hybrid between Japanese race Jam 307 (breeding line D98) and

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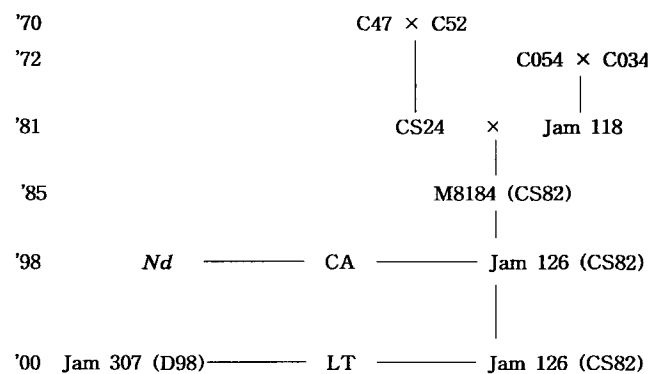
Chinese race Jam 126 (breeding line CS82). For the target to breed the naked pupation pure lines with a heavier weight of pupae, Japanese pure line Jam 307 was selected from stock line of naked pupae (Nakano, 1951; Watanebe, 1959), and Chinese race pure line Jam 126 was hybrid crossed between breeding line of CS24 and Jam 118 (Sohn *et al.*, 1987).

Target characters were selected through twice, succeeding rearing in a year by mass selection in a mixed batch rearing system based on non-cocooning quality. Hachojam was selected as the variety with an excellent combination in the combining ability test in later autumn rearing season of 1998, and it passed the test of pure line characteristics and adaptability test for autumn rearing season, performed at the Department of Sericulture and Entomology, National Institute of Agricultural Science and Technology (NIAST), and seven Provincial Institute of Agricultural Science and Technology (PIAST), Korea, in autumn rearing season of 1999 to 2000. It was nominated as a new recommended variety suitable for autumn rearing season with the name of Hachojam by Nomination Council of Silkworm Recommended Variety (NCSR) after the superiority as an autumn variety was recognized through the local adaptability test performed at seven sericultural organizations of PIAST.

## Results and Discussion

### Combining ability test

For the breeding of a new silkworm variety suitable for autumn rearing season, Japanese race Jam 307 and Chinese race Jam 126 were crossed. Jam 307 (breeding line D98), Japanese pure line, was selected from stock lines, and Jam 126 (breeding line CS82), Chinese race pure line,



**Fig. 1.** The Pedigree of Hachojam, the F<sub>1</sub> hybrid between Jam 307 × Jam 126. CA, Combining ability test; LA, Local adaptability test. Names in parenthesis represent those for breeding line.

was bred between breeding line of CS24 and Jam 118 (Sohn *et al.*, 1987). The F<sub>1</sub> hybrid between Jam 307 and Jam 126 was selected as Hachojam (Fig. 1). The economic characteristics of Jam 307 and Jam 126 were described in Table 1.

The major commercial characteristics of Hachojam reared during later autumn rearing season in 1998 are shown in Table 2. The results of Hachojam were compared with the reference variety Daesungjam. Hachojam recorded relatively high naked pupation rate of 78.3% and showed heavier single pupal weight (1.87 g) than Daesungjam (1.54 g), but pupation rate between them were similar. High naked pupation rate in the Hachojam represents the characteristic of the non-cocooning variety, as shown in Fig. 2.

### Local adaptability test

**Rearing score** Cooperative experiment for the productivity test and local adaptability of Hachojam was per-

**Table 1.** The economic characteristics of the parental lines, Jam 307 and Jam 126, of Hachojam obtained during autumn rearing in 1998

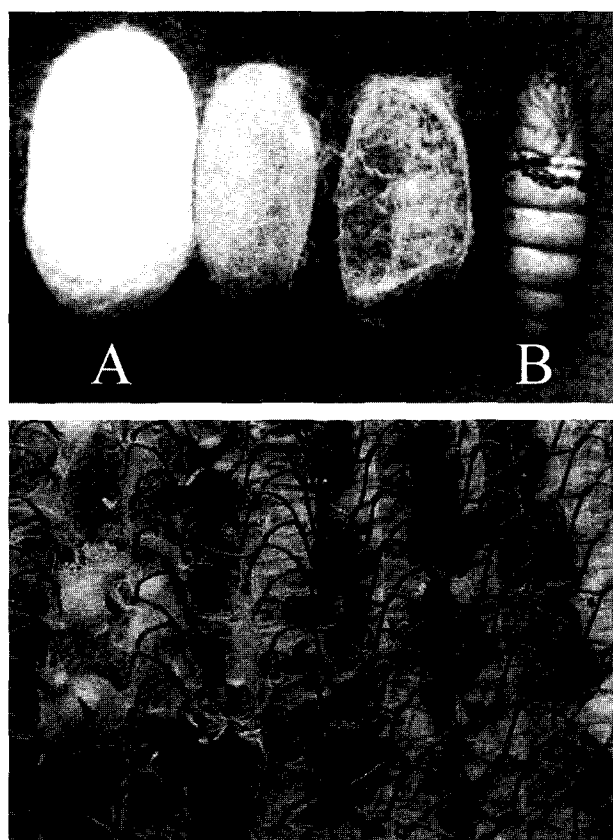
Line	Larval period (days)	Pupation rate (%)	Naked pupation rate (%)	Thin cocoon rate (%)	Single pupal weight (g)
Jam 307	25.23	69.0	92.2	7.8	1.05
Jam 126	22.23	86.5	-	-	1.86

-, Not detected.

**Table 2.** The major commercial characteristics of Hachojam of the combining ability test performed during later autumn rearing in 1998

Variety	Useful hatchability (%)	Larval period (days)	Pupation rate (%)	Naked pupation rate (%)	Thin cocoon rate (%)	Single pupal weight (g)
Daesungjam	96	23.20	87.4	-	-	1.54
Hachojam	94	23.05	86.2	78.3	21.7	1.87

-, Not detected.



**Fig. 2.** The pupation stage of Hachojam, non-cocooning silkworm variety. Cocoon producing silkworm variety (A of upper panel) formed cocoon, but Hachojam (B of upper panel, lower panel) did not.

formed at the Department of Sericulture and Entomology, NIAST, and seven provincial sericultural organs concerned (PIAST). The mean values of the test are shown in Table 3. The useful hatchability of Hachojam was over 90% of recommending criteria for a new variety. This

value is similar to check variety Daesungjam. The larval duration of Hachojam was eleven hours longer than that of check variety. Naked pupation rate and thin cocoon rate of Hachojam were 64.7% and 35.3%, respectively. Pupal weight of Hachojam was 1.95 g, and pupal yield crops was heavier by 3.4 kg than check variety, which showed 14.2 kg per 10,000 of the 3rd molted larvae. The result indicates that the pupal weight of Hachojam increased approximately 24% compared with check variety. The values of the naked pupation rate and pupal weight suggest that Hachojam can be used as high-yielding and labor-saving variety for the production of dongchunghacho. Furthermore, this variety also will be useful as a host for the production of blood glucose-lowering material, functional food materials, and heterologous proteins by baculovirus expression vector system (Yamazaki *et al.*, 1997), because the cocoon-making process is not required.

**Adaptability test for the artificial diet** The results of the adaptability test for the artificial diet in the young Hachojam silkworm are illustrated in Table 4. On the basis of several values compared with the control variety Baegokjam, which was widely propagated for artificial diet, Hachojam was not recommendable as the silkworm variety reared by artificial diet.

#### Main characteristics of parental lines

The major characteristics of Jam 126 and Jam 307, which are parental lines of Hachojam were examined with Jam 123 and Jam 124, which are parents of Baegokjam, as controls are illustrated in Table 5. Japanese race Jam 307 showed a normal marking on the larval body, and the process for the naked pupation was usual. The pupation rate of this race (88.8%) was a little bit higher than that of the check variety Jam 123 which was 86.9%. However fecundity of Jam 307 showed a lower number of 348 compared 506 of Jam 123.

**Table 3.** Rearing results of Hachojam through the local adaptability test performed at 8 places during autumn rearing season in 2000

Variety	Useful hatchability (%)	Larval period (days)	Pupation rate (%)	Naked pupation rate (%)	Thin cocoon rate (%)	Pupal weight (g)	Pupal yields per 10,000 3rd molted larvae (kg)
Daesungjam	96	24.03	91.9	-	-	1.54	14.2
Hachojam	95	24.14	90.7	64.7	35.3	1.95	17.6

-, Not detected.

**Table 4.** Adaptability test for the artificial diet performed during spring rearing season in 2000

Variety	Bristling rate (%)	Larval period from 1st to 3rd instar (days)	Molting rate (%)			Adaptability
			2nd	3rd	4th	
Backkokjam	96	12.08	96	95	96	Good
Hachojam	85	12.08	76	94	93	-

-, Not recommended.

**Table 5.** The major commercial characteristics of the parental lines of Hachojam

Variety	Useful hatchability (%)	Larval period (days)	Pupation rate (%)	Cocoon yield per 10,000 3rd molted larvae (Kg)	Single cocoon weight (g)	Cocoon shell weight (cg)
Japanese races						
Jam123	96	24.07	86.9	15.7	1.86	46.4
Jam307	96	23.06	88.8	-	-	-
Chinese races						
Jam124	95	22.06	95.4	18.4	2.03	46.8
Jam126	98	22.13	96.0	19.0	2.07	47.5

Variety	Percentage of moth emergence (%)	Duration from incubation to moth emergence (days)	No. of eggs per batch (ea)	Percentage of moth laid normal eggs (%)	Laval marking	Cocoon shape
Japanese races						
Jam123	99	57	506	78	mark	peanut
Jam307	92	52	348	83	mark	-
Chinese races						
Jam124	100	54	614	89	plain	elliptical
Jam126	99	54	589	72	plain(M), mark(F)	elliptical

-, Not detected; M, Male; F, Female.

Chinese race Jam 126 showed a sex-bases larval marking: body marking on female and plain on male with elliptical cocoon shape. The pupation rate and cocoon yields by 10,000 3rd molted larvae with 96% and 19.0 kg were similar to those of check variety Jam 124, and fecundity with 589 each per moth was slightly decreased than that of 614 each of Jam 124.

In conclusion, a new silkworm variety, Hachojam, showed higher naked pupation rate and heavier pupal yields than check variety. This Hachojam can be used as a host to produce biomaterials such as heterologous proteins and dongchunghacho.

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