

An Appraisal of Silk from *Anaphe venata* Butler (Lepidoptera: Notodontidae) and Methods of Degumming

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ABSTRACT

The physical properties of the silk of *Anaphe venata* were measured after degumming the cocoons in water, sodium carbonate, ash effluent and dilute hydrochloric acid. The best degumming results were obtained with the ash effluent, 1% and 2% sodium carbonate solutions. *A. venata* has potential in the silk industry in Nigeria, but a more thorough examination of its bionomics is needed.

INTRODUCTION

Various workers such as Ene (1965) and Golding (1944) have made useful contributions on the distribution, bionomics and biology of *Anaphe venata* Butler (Lepidoptera: Notodontidae) and *Gastroplakaeis rufescens* (Tams) (Lepidoptera: Lasiocampidae), two silk-producing moths, respectively. Ene (1965), Lehman (1913) and Akerele (1970) have also contributed information on the physical properties, sericultural technique and silk production.

The larvae of eight moth species produce usable silk in Nigeria. These are *Anaphe infracta* Wls., *A. venata* Butl., *A. reticulata* Walk., *A. carteri* Wals., *A. moloneyi* Druce, *A. vUILLETII* de Juann, *Gastroplakaeis rufescens* Aur. and *Epiphora bauhiniae* Guer. (Ene 1965). Ene also stressed that, examined from the biological, ecological, cultural and economic points of view, the *Anaphe* silks in Nigeria should eventually succeed in the world market.

Akerele (1970) observed a great decline in local silk production in recent years. He noticed that the local industry could be revived and further developed if the wild silk-worms could be domesticated and the sericultural, reeling and other aspects of silk-fibre production improved and modernised.

This report deals with the effect of different degumming media on the silk of *A. venata*. Its biology has already been reported (Ashiru, 1975).

MATERIALS AND METHODS

Larvae and cocoons of *A. venata* were collected from *Triplochiton scleroxylon* K. Schum in September 1972. These were reared and emerging moths collected. Male and female adults were caged in groups of two and ten to effect mating. The batches of eggs obtained were used for life-history studies. The weights and dimensions of cocoons spun in the laboratory and in the field were recorded and compared.

Cocoons were degummed in water, sodium carbonate solution, dilute hydrochloric acid or ash effluent, the method used by local weavers. The sodium carbonate method was used (Akerele, 1970). The water and dilute hydrochloric acid methods have not been used previously.

A. Individual cocoons

1. *Water*

Two cocoons were boiled in water for 5, 4, 3, 2 hours, 1 or ½ hours

2. **Sodium carbonate (Na₂CO₃) solution**

Two cocoons were boiled in 5%, 4%, 3%, 2%, or 1% solutions of sodium carbonate for 2 hours, 1 hour, or ½ hour. The cocoons were then washed in soap solution and finally water.

3. **Dilute hydrochloric acid (HCL)**

Two cocoons were boiled in 5%, 4%, 3%, 2% or 1% solutions of hydrochloric acid for 2 hours, 1 hour or ½ hour. The cocoons were then washed in soap solution and finally water.

4. **Ashes**

A handful of ash was stirred in 500cc of water. The mixture was decanted into a flask and the effluent used to boil two cocoons for 2 hours, 1 hour or ½ hour.

B. Communal cocoons¹

1. *Water*

Two cocoons were boiled in water for 1 hour. The papery communal cover was opened and the individual cocoons removed. They were dried, opened and the individual cocoons teased apart to fibres. The weight of raw silk obtained from the two original communal cocoons was recorded.

2. **Sodium carbonate solution**

Two cocoons were boiled in sodium carbonate solution for 1 hour. The papery communal cover was opened and the individual cocoons removed. All cocoons were washed in a dilute soap solution and placed under running water until the soap was removed. They were then treated as in (1) above.

3. **Dilute hydrochloric acid**

Treatment as in (2) except that the cocoons were boiled in a dilute hydrochloric acid solution.

A communal cocoon is a collection of individual cocoons within a papery cover.

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4. Ashes

A handful of ashes was stirred in 500cc of water. The mixture was decanted into a flask and the effluent used to boil two cocoons for 1 hour. The cocoons were then treated as in (2) above

The relative ease of teasing and the colours of the raw silk produced were observed and fibre diameter and thread strength were recorded. Fibre diameter was determined by the Federal Institute of Industrial Research, Oshodi, and thread strength was determined by pulling threads apart by hand as there was no suitable equipment available. Reelable silk weight and reelable silk ratios¹ were calculated and compared for cocoons spun in the laboratory and in the field. The reeling of thread was done on a spool—an instrument used by the local weavers. Thread sizes were classified as fine, medium and coarse (Plate 1).

Weavers were interviewed on the local use of the silk of *A. venata* in a survey conducted in Ondo division of the former Western State.

$$1. \text{ Reelable silk ratio} = \frac{\text{Reelable silk}}{\text{Cocoon wt.}} \times 100$$

RESULTS

The dimensions (cm) and weight (gm) of 37 communal cocoons spun in the field were: length 6.45, 2.54, 15.24 (mean, minimum and maximum respectively); breadth 3.99, 1.27, 10.16; and weight 3.63, 0.1, 25.3. For 24 communal cocoons spun in the laboratory, results were length 5.89, 1.27, 19.05; breadth 3.84, 1.27, 8.89; and weight 1.66, 0.09, 5.2.

Cocoons boiled in water for periods ranging from ½ hour to 5 hours showed urtication. They were light brown to greyish brown (Table 1). Teaseability into fibre was low but threads spun from the fibres were very strong. Those boiled in ash effluent for between ½ hour to 2 hours were brownish white to greyish white with average to high teaseability. Spun thread were strong.

Cocoons boiled in 1%, 2%, 3%, 4% and 5% sodium carbonate for ½ hour to 2 hours in each solution, were light brown through brownish white to greyish white (Table 2). Teaseability was average to high and thread strength ranged from very strong to strong, slightly weak and very weak. When boiled in 3% to 5% sodium carbonate for 2 hours, thread strength was very weak.

Table 1 **Physical properties of degummed and teased *Anaphe venata* cocoons**

Degumming agent	Period	Colour	Teaseability	Thread strength	Remarks
Water	30 mins	Light brown	Low	Very strong	Cocoon papery with well defined shape. Fibre masses spinnable into threads on teasing.
	1 hr.	Greyish brown	Low	Very strong	—do—
	2 hrs.	Greyish brown	Low	Very strong	—do—
	3 hrs.	Greyish brown	Low	Very strong	—do—
	4 hrs.	Greyish brown	Low	Very strong	—do—
	5 hrs.	Greyish brown	Low	Very strong	—do—
Ash effluent	30 mins.	Brownish white	Average	Strong	Cocoon shape and paperiness slightly retained. Fibre masses spinnable into threads on teasing.
	1 hr.	Greyish white	High	Strong	Cocoon shape and paperiness completely lost. Fibre masses spinnable into threads on teasing.
	2 hrs.	Greyish white	High	Strong	—do—

Table 2
Physical properties of degummed and teased *Anaphe venata* cocoons (Na₂CO₃ treatment)

Degumming Agent	Period	Colour	Teaseability	Thread strength	Remarks
1% Sodium carbonate	30 mins.	Light brown	Average	Very strong	Fairly soft to tease with shape almost completely lost. Fine and strong thread produced.
	1 hr.	Brownish white	High	Strong	Soft to tease with shape completely lost. Very fine thread produced.
	2 hrs.	Brownish white	High	Strong	—do—
2% Sodium carbonate	30 mins.	Brownish white	High	Slightly weak	Soft to tease cocoons shape completely lost. Fine threads.
	1 hr.	Brownish white	High	Slightly weak	—do—
	2 hrs.	Brownish white	High	Slightly weak	—do—
3% Sodium carbonate	30 mins.	Brownish white	High	Slightly weak	—do—
	1 hr.	Greyish white	High	Slightly weak	—do—
	2 hrs.	Greyish white	High	Very weak	Same as above but spun into threads.
4% Sodium carbonate	30 mins.	Greyish white	High	Very weak	—do—
	1 hr.	Greyish white	High	Very weak	—do—
	2 hrs.	Greyish white	High	Very weak	—do—
5% Sodium carbonate	30 mins.	Greyish white	High	Very weak	—do—
	1 hr.	Greyish white	High	Very weak	—do—
	2 hrs.	Greyish white	High	Very weak	—do—

Table 3
Physical properties of degummed and teased *Anaphe venata* cocoons (Dil. HCl treatment)

Degumming agent	Period	Colour	Teaseability	Thread strength	Remarks
1% Dilute HCl	30 mins.	Light brown	Low	Very weak	Cocoon papery with well defined shape. Fibre masses spin into very short threads.
	1 hr.	Light brown	Low	Very weak	—do—
	2 hrs.	Light brown	Average	Very weak	—do—
2% Dilute HCl	30 mins.	Light brown	Low	Very weak	Cocoon shape and paperiness slightly retained. Fibre spinnable into very short threads.
	1 hr.	Light brown	Average	Very weak	Cocoon shape slightly soft to tease and shape complete. Fibre masses not spinnable into threads.
	2 hrs.	Light brown	High	Not spinnable	Cocoon soft to tease and shape completely lost. Fibre masses not spinnable into threads.
Dilute HCl	30 mins.	Brownish white	High	Not spinnable	—do—
	1 hr.	Brownish white	High	Not spinnable	—do—
	2 hrs.	Brownish white	High	Not spinnable	Very soft to tease and shape completely lost.
Dilute HCl	30 mins.	Whitish brown	High	Not spinnable	—do—
	1 hr.	Brownish white	High	Not spinnable	—do—
	2 hrs.	Brownish white	High	Not spinnable	—do—

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Table 3 (contd)

	30 mins.	Brownish white	High	Not spinnable	Highly soft to tease and shape completely lost.
5% Dilute HCl	1 hr.	Brownish white	High	Not spinnable	—do—
	2 hrs.	Brownish white	High	Not spinnable	—do—

Those boiled in 1%, 2%, 3%, 4% and 5% dilute hydrochloric acid for ½ hour to 2 hours in each solution were light brown through whitish brown to brownish white (Table 3). Teaseability was low, average or high. The strength of thread obtained from cocoons boiled in 1% and 2% acid solutions was very weak. At higher concentrations, fibres were not spinnable into threads.

Fibre diameters for cocoons degummed in 5% Na₂CO₃, ash, 5% dilute hydrochloric acid and water are presented in Table 4.

Table 4 **Diameter determination for degummed *A. venata* fibres**

Degumming Agent	5% Na ₂ CO ₃	Ash	5% HCl	Water
Mean Fibre*				
Diameter u (micron)	14.5*	15.8	13.3	20.6
Range u (micron)	6-30	10-26	2-22	8-44
Standard Deviation	1.83	1.33	2.11	2.52
Coefficient of Variation (%)	12.6	8.4	15.8	12.2

* There were 200 measurements for each sample.

(Table 5 **Releable weights and ratios of silk masses after degumming**

	Degumming agent	Cocoon wt. (gm)	Releable silk (gm)	Releable silk ratio + (%)	Mean wt. of cocoon (gm)	Range (gm)	Standard deviation
Laboratory* Cocoons	Water	0.55	0.15	27.3	0.15	0.02-0.43	0.07
	Effluent	0.54	0.17	31.5	0.17	0.08-0.38	0.12
	Sodium Carbonate	1.19	0.74	62.2	0.74	0.03-3.02	0.17
	Dilute HCl	1.25	0.31	24.8	0.31	0.10-0.55	0.08
Field** Cocoons	Water	0.39	0.16	41.9	0.16	0.07-0.41	0.01
	Effluent	3.81	0.81	21.2	0.81	0.16-2.04	0.12
	Sodium carbonate	4.02	0.76	18.9	0.76	0.19-2.43	0.10
	Dilute HCl	1.03	0.56	54.0	0.56	0.18-1.20	0.07

+ Releable silk ratio = $\frac{\text{Releable silk}}{\text{Cocoon wt.}} \times 100$

* Means of 5 measurements
** Means of 7 measurements

The reelable silk ratio (Table 5) for laboratory cocoons was low, 27.3% (water), 31.5% (effluent), 24.8% (Dil. HCl) and 62.1% (Na₂CO₃). With the field cocoons it was 41.9% (water), 21.2% (effluent), 18.9% (Na₂CO₃) and 54.0% (HCl).

A survey carried out in Ondo area showed that the use of *A venata* silk in the local industry is fast declining. The local weavers interviewed attributed this decline to the fast rate of consumption of the host tree *Triplochiton scleroxylon* in their localities. Without the host adults and larvae disappear.

DISCUSSION AND CONCLUSION

Boiling cocoons of *A. venata* in water for ½ hour to 5 hours, 1% - 3% sodium carbonate for 1 hour and ash effluent for ½ hour to 2 hours produced spinnable fibre masses. However, boiling in water was unsuitable because of urtication and incomplete degumming.

Fibres degummed in 5% Na₂CO₃ and 5% HCl solution appear to be over-degummed and disintegrated while fibres treated with water appeared to be undegummed. Best results have been obtained with fibres degummed in ash, 1% and 2% solutions of sodium carbonate. The result of boiling cocoons in 1% - 3% Na₂CO₃ does not support the resistance to mild alkali attributed to *A. venata* silk by Lehman as cited by Ene (1965).

Cocoons spun in the laboratory were smaller than those collected from the field. The difference in size may be due to unsuitable laboratory conditions. This view is supported according to Ene (1965), by Gowdey who stated that important points to be borne in mind in the rearing of the *Anaphe* silkworms are:

- (1) the larvae require a large supply of food,
- (2) shade is essential for their well being, and
- (3) disturbance of the larvae is fatal.

Condition one was adequately met. Although the rearing room and cage provided some shade, the amount of shade was less than that of the natural environment. The degree of disturbance to the larvae was minimal as larvae were only disturbed in the mornings when food was introduced to their cages.

Results of reelable silk ratio observed for laboratory cocoons and field cocoons (Table 5) are only preliminary because of the limited number of cocoon samples, five and seven respectively, used in the degumming process. Further work is therefore needed to confirm this finding. Akerele (1970) obtained 33.5% clean degummed fibres after degumming in 3% sodium carbonate. This is less than the 62.2% obtained with 3% sodium carbonate in the present study. However, the initial cocoon numbers, weight and final weight that he observed were not stated.

Anaphe venata silk appears to have good potential in the silk industry in Nigeria. More thorough examination of its ecology, behaviour and other characteristics need to be worked out. Only in this way can we achieve domestication of this particular species for use in a silk industry.

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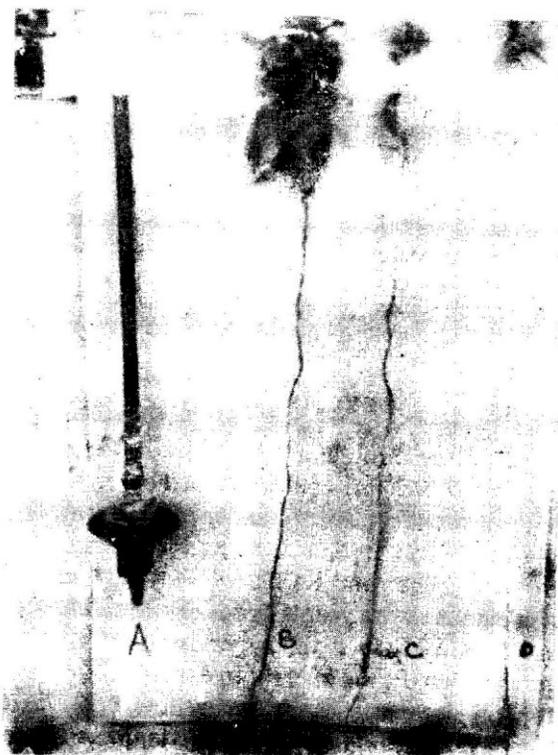


PLATE 1.

- A. Spool
- B. Coarse thread
- C. Medium thread
- D. Fine thread