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New development fiber material : use DoE approach to determine the best formula for blended fiber silk (Samiya Cynthia Riccini and Semi-Natural Fiber)

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Abstract. Many research studied the silk with the filament fiber, which mean if the cocoon broke due to the larva become butterfly earlier, the cocoon will become waste. This paper studied with the broken cocoon and show to spin and become more value-added products. The broken cocoon will be processed with mechanical spinning method in order to become more value-added product, the product is Silk Yarn Blended. The objective of this paper is to determine factor and find the best blend material formula to make a new development of yarn from the broken cocoon of Samia Cynthia Riccini worm, and make a qualified yarn. From the three experiment it appears that the unevenness and strength are increasing. Unevenness and strength have the highest frequency of occurrence so that it becomes a priority for completion. Quality of the yarn from experiment 3.1, 3.2, and 3.3 increase for strength which is good, and decrease for the unevenness which is also good, and the both of unevenness and strength, can meet with the standard requirement. The best formula of this research paper can be applied in the Textile Industry, and combined between silk and semi-natural fiber will be the best choice for production in the future.

1. Introduction

There is seven main stage to complete experimental design research, first it should be there is an introduction, experimental planning, experimental action, analyze, confirmation, discussion, and conclusion [1]. This paper will make an Experimental design approach to find the variable factor included dependent variable and independent variable. To show the best possibility of determining the factor to get the best formula of new yarn development form silk fiber blended, without counting variants with the statistic.

As a Kind of Industry, Silk industry included agro-based industry. And silk industry is focused on India wich stand stands 2nd highest position and the sole monopoly power in the production of silk, one kind of them is Muga silk among the all over the world[2]. Not only Muga silk, but the Noeht-Eastern region of India also practicing sericulture another kind of silk are mulberry, muga, and eri [2].

In India, after 1990, though the nature of state transferred to a minimal state, the forces of democracy have compelled the state to be an integrative state which gave importance on both public welfare and market needs[3]. Some of the various populist measures of the State in the Muga sector and increasing awareness and competitiveness of Muga growers' due to globalisation, gave a new lifeline to the Muga silk industry[3].

2. Method and Experimental Planning Stage

2.1. Problem Statement (Issue)

Many research for Silk included Eri silk one of the results from Samia Cynthia Riccini worm is told about how to develop the good cocoon with adjusting some factor are, temperature, RH, and feeding Frequencies [4]. In the other side (Gupta et all, 200) studied with the silk in order to find the fiber fineness is one of the physical characteristics and structures of the four commercial varieties of Indian silk fibers, are Mulberry, Tasar, Eri and Muga[5]. But that is observed the silk filaments only, from the same cocoon show considerable variation in linear density[5].

The research moves forward to how to give a color or print in the silk with natural dyes and discharge printing[6]. And this paper will be complete the step before silk yarn or fabric dye.

Many research studied the silk with the filament fiber, wich mean if the cocoon broke due to the larva become butterfly earlier, the cocoon will become waste.

We studied with the broken cocoon and show to spin and become more value-added products. The broken cocoon will be processed with mechanical spinning method in order to become more value-added product, the product is Silk Yarn Blended.

Physical properties of Eri silk was studied by Boruah et all, 2015 and found the silk have some physical characteristic[7].

2.2. Objective

The objective of this paper is to determine factor and find the best blend material formula to make a new development of yarn from the broken cocoon of Samia Cynthia Riccini worm, and make a qualified yarn.

2.3. Independent Variable Determination

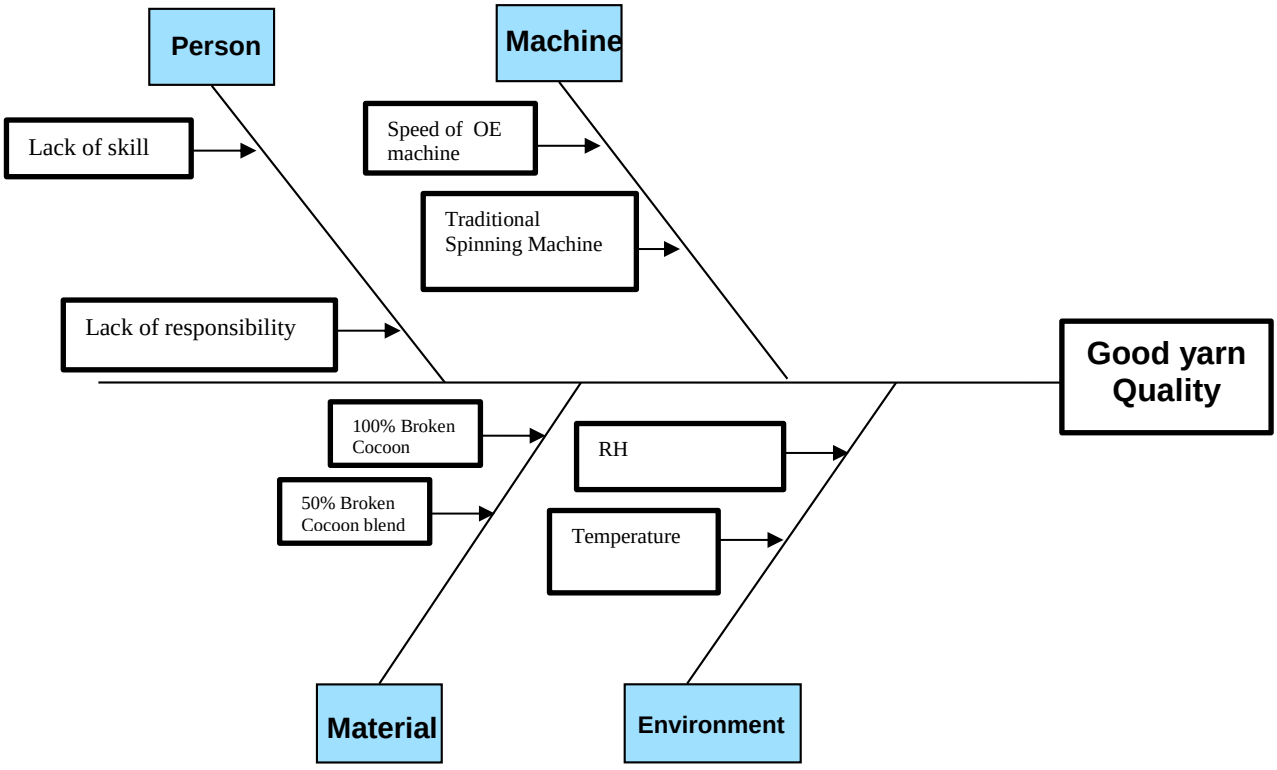

Figure 1 Fishbone Diagram

From the Fig. 1 Fishbone Diagram, founded that independent variable for Silk yarn blended is on Material and machine, we can find the table below.

Table 2.3 Independent Variable

Variable Control	
No	**Variable**
1	Full broken cocoon Material (100% Silk)
2	Blended Material 50% Broken cocoon
3	Using traditional machine
4	Using OE Machine

Source : data processed 2018

3. Results and Discussion

3.1. Result Full Broken Cocoon Material Using Traditional Spinning Machine

After doing an experiment for making a yarn with the 100% broken cocoon material (Samiya Cyntia Riccini/Eri Silk) the yarn is successfully created but with the high unevenness of yarn and low strength. The result of the test is described in the table below :

Table 3.1.1 Yarn Unevenness Check (100% Silk)

Test N. S / T	Machine name	Um%	CVm%	CVm% 1m	CVm% 3m	Index	Count Rel. %	Thin/km -50%	Thick/km +50%	Neps/km +200%	H
1 / 1	—	31,73	40,16	18,88	12,20	10,02	-12,71	7280,0	4800,0	40,0	11,02
1 / 2	—	26,82	33,44	13,20	4,89	8,35	5,44	4760,0	3640,0	80,0	10,81
1 / 3	—	28,28	35,56	13,38	7,56	8,88	-2,39	5080,0	4320,0	40,0	11,49
1 / 4	—	27,92	34,93	16,43	10,41	8,72	-4,53	5560,0	3920,0	120,0	10,62
1 / 5	—	27,37	33,26	12,24	7,77	8,30	14,19	6000,0	4440,0	40,0	11,01
AVG.		**28,42**	**35,47**	**14,83**	**8,57**	**8,85**	**0,00**	**5736,0**	**4224,0**	**64,0**	**10,99**
MIN.		26,82	33,26	12,24	4,89	8,30	-12,71	4760,0	3640,0	40,0	10,62
MAX.		31,73	40,16	18,88	12,20	10,02	14,19	7280,0	4800,0	120,0	11,49
R		4,91	6,90	6,64	7,31	1,72	26,90	2520,0	1160,0	80,0	0,87
CVb%		6,79	7,89	18,60	32,88	7,87	10,23	17,0	11,0	56,0	2,95
s		1,93	2,80	2,76	2,82	0,70	10,23	983,0	453,0	36,0	0,32
Q95%		2,40	3,47	3,42	3,50	0,86	12,70	1221,0	562,0	44,0	0,40

Source: *Covatest Unevenness Tester*

From the table above we find that average unevenness (Um%) is 28,42% wich mean from the 100% yarn, there is 28,42% out of standard or unevenness. The standard for unevenness for yarn in Central Java Textile Industry is maximum 13,00%. Beside unevenness, the strength of the yarn is important, the strength for the first formula are described in the table on the next page below:

Table 3.1.2 Yarn Strength Check

No of Test	**CN**	**CN/Tex**	**E**	**Ne**
1	242	2.4	1.0	5.930
2	263	2.6	0.85	5.930
3	676	6.8	2.3	5.930
4	848	8.5	2.6	5.930
5	439	4.4	1.5	5.930
$\bar{x}$	**494**	**5.0**	**1.7**	**5.930**
S	**264**	**2.6**	**0.77**	**0.00**

No of Test	CN	CN/Tex	E	Ne
V	**53.45**	**53.45**	**46.44**	**0.00**
Min	**242**	**2.4**	**0.85**	**5.930**
max	**848**	**8.5**	**2.6**	**5.930**

Source : *Yarn Tensile Strength and Elongation Tester*

From the table 3.1.2 we can find that the coefficient variant is 53%, this is no good for the quality of the product, and the tenacity or strength of the yarn is 5.0 in average, if we compare with Central Java Textile Industry standard for strength the minimum is 9.0 cN/Tex. Because of that, we still have to improve the unevenness and strength of the yarn.

3.2. Result Full Broken Cocoon Material using OE machine

Broken cocoon material after processed using Open End machine, there is an improvement on strenght of the yarn. The result of the 2nd test is described in the table below :

Table 3.2.1 Yarn Strength Check (100% with OE Machine)

No of Test	CN	CN/Tex	E	Ne
1	741	7.4	2.6	5.930
2	883	8.9	2.7	5.930
3	984	9.9	3.1	5.930
4	727	7.3	1.9	5.930
5	589	5.9	1.9	5.930
$\bar{x}$	**785**	**7.9**	**2.4**	**5.930**
S	**152**	**1.5**	**0.51**	**0.00**
V	**19.42**	**19.42**	**20.92**	**0.00**
Min	**589**	**5.9**	**1.9**	**5.930**
max	**984**	**9.9**	**3.1**	**5.930**

Source : *Yarn Tensile Strength and Elongation Tester*

From table 3.2.1 we can find improvement quality that the coefficient variant before is 53% and decrease become 19.42%, this is good for the quality of product, and the tenacity or strength of the yarn before is 5.0 in average increased become 7.9, if we compare with Central Java Textile Industry standard for strength the minimum is 9.0 cN/Tex. Because of that, we still have to improve the strength of the yarn.

3.3. Result for Blended Material 50% Broken Cocoon Blended with Semi-Natural Fiber Using OE Machine

After doing improvement experiment for making a yarn with blended material 50% broken cocoon silk and 50% semi-natural fiber, the yarn is successfully meet the requirement and can pass the control limit unevenness of yarn and strength. The result of the test is described in the table below :

Table 3.3.1 Yarn Unevenness Check
(Blended broken cocoon Silk 50% with 50% semi-natural fiber)

Test N. S / T	Machine name	Um%	CVm%	CVm% 1m	CVm% 3m	Count Rel. %	Thin/km -50%	Thick/km +50%	Neps/km +280%	H
1 / 1	---	12,31	15,80	8,45	6,29	0,51	16,0	32,0	160,0	4,84
1 / 2	---	11,70	15,12	7,16	4,95	0,70	32,0	32,0	80,0	4,85
1 / 3	---	12,47	15,97	8,41	5,76	0,58	16,0	0,0	128,0	4,98
1 / 4	---	12,98	17,00	9,70	7,62	-0,74	32,0	96,0	192,0	4,68
1 / 5	---	12,97	16,51	9,97	7,04	-1,05	16,0	16,0	96,0	4,47
AVG.		**12,49**	**16,08**	**8,74**	**6,33**	**0,00**	**22,0**	**35,0**	**131,0**	**4,76**
MIN.		11,70	15,12	7,16	4,95	-1,05	16,0	0,0	80,0	4,47
MAX.		12,98	17,00	9,97	7,62	0,70	32,0	96,0	192,0	4,98
R		1,28	1,88	2,81	2,67	1,75	16,0	96,0	112,0	0,51
CVb%		4,25	4,44	12,95	16,57	0,83	39,0	104,0	35,0	4,11
s		0,53	0,71	1,13	1,05	0,83	9,0	36,0	46,0	0,20
Q95%		0,66	0,89	1,41	1,30	1,03	11,0	45,0	57,0	0,24

Source: *Covatest Unevenness Tester*

From table 3.3.1 above we find that average unevenness (Um%) is 12,49% wich mean meet the standard of unevenness. The standard for unevenness for yarn in Central Java Textile Industry is maximum 13,00%. And for the strength of the yarn are described in the table below:

Table 3.3.2 Yarn Strength Check
(Blended broken cocoon Silk 50% with 50% semi-natural fiber)

No of Test	CN	CN/Tex	E	Ne
1	593	10.0	5.8	10.00
2	610	10.3	5.0	10.00
3	553	9.4	5.4	10.00
4	587	9.9	5.4	10.00
5	539	9.1	5.1	10.00
6	541	9.2	5.3	10.00
7	576	9.8	6.0	10.00
8	659	11.2	5.5	10.00
9	607	10.3	5.6	10.00
10	546	9.2	5.5	10.00
$\bar{x}$	**581**	**9.8**	**5.5**	**10.00**
S	**38.2**	**0.6**	**0.30**	**0.00**
V	**6.57**	**6.57**	**5.41**	**0.00**
min	**539**	**9.1**	**5.0**	**10.00**
max	**659**	**11.2**	**6.0**	**10.00**

Source : *Yarn Tensile Strength and Elongation Tester*

From table 3.3.2, the strength of the yarn is increse from 7.9 in average become 9.8 in average, and for coefficient variant before is 19.42% become 6.57%, this is very good for the quality of product, and can meet with requirement of Central Java Textile Industry standard for strength the minimum is 9.0 cN/Tex.

4. Conclusion

From three times experiment we can find that there is 3 formula to make a yarn, from the three formula there is one the best blend material and formula that we can apply in Industry. This research is opened to improve the result of the product.

There is a paper studied with international and national scenario of commercial production and market share of silk fabrics, and it will be good for the local content material (silk) with particular

reference to process along with machine control parameters followed by adoption of good practices in the preparatory stages during production of the silk fabric in a commercial Silk Mill[8].

From the data analysis that has been done, from the three experiment it appears that the unevenness and the strength are increasing. Unevenness and strength have the highest frequency of occurrence so that it becomes a priority for completion.

The conclusion of result of the three times experiment are described in the table below:

Table 4 Quality Comparison of yarn

Kind of Experiment	Strength	Unevenness	Remarks
3.1	5.0	28.42	*Full broken cocoon Material Using Traditional spinning machine*
3.2	7.9	-	*Full Broken Cocoon Material using OE machine*
3.3	9.8	12.49	*Blended material 50% broken cocoon blended with semi-natural fiber using OE Machine*

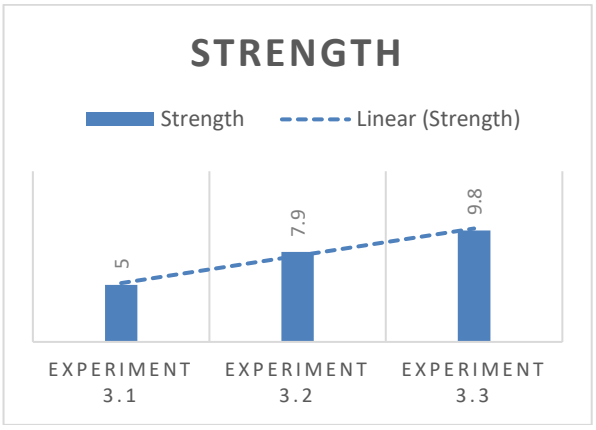

Figure 2 Graphic of Strength yarn

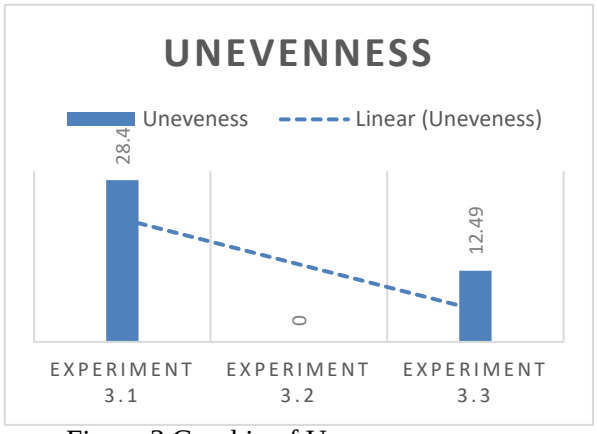

Figure 3 Graphic of Unevenness yarn

From the graphic on Figure 2 and Figure 3 above seen that the yarn from experiment 3.1, 3.2, and 3.3 is increase for strength which is good, and decrease for the unevenness which is also good, and the both of unevenness and strength, can meet with the requirement.

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