



Innovative Rice Straw Fibers Mixed Fibers from Cocoons to Develop Textiles to Further Develop Fashion Lifestyle Products:

A Case Study of Khwao Sinarin Sub-district, Khwao Sinarin District, Surin Province

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Received: 17 June 2021; Revised: 14 September 2021; Accepted: 21 September 2021

Abstract

The purpose of this research was to analyze and tested the fiber composition of rice straw cultivar, type Kor Khor-15. Studied the properties of yarn made from rice straw fibers mixed cocoon fibers. Studied the design of ikat silk fabric patterns. Studied the design of clothing products and method was carried out by testing the fiber composition of rice straw type Kor Khor-15 in the area of village 2 Khwao Sinarin sub-district. Create rice straw fibers mixed original cocoon fibers. Test the physical properties of the yarn. Design ikat silk pattern and create a prototype clothing product. The satisfaction assessment reported that the fiber composition of rice straw type Kor Khor-15 had an average percentage of cellulose was 41.30%, hemicellulose was 26.66%. The yarn was tested by a single fiber strength tester (Tensile-Strength) in fiber testing laboratory at Department of Plant Science, Textiles and Design, Faculty of Agriculture and Technology, Rajamangala University of Technology Isan Surin Campus. The mean strength was 184.16 newton, the mean elongation was 5.868 cm, the mean toughness was 2.24 cN/T, the mean elongation was 11.73% and the mean elongation strength was 138.83 newton. The rice straw fibers had a high cellulose fiber content that gave the yarn strength and good elongation. Rice straw fiber was a short fiber when spun into yarn and then used to dye, some fibers would be loosened which can improve the durability of the fibers in the future. Pattern designed with shortening, alternating left-right and rotating around the dots. Strung until the shape as designed processed into clothing products. The satisfaction assessment results were at a high level. Technology development to enhance wisdom to commercial innovation abled to made the community self-reliant in a sustainable way.

Keywords: Innovation, Rice Straw Fiber, Textile, Products, Surin Province

Introduction

Rice planting is the main occupation of the people in the province. After the harvest season, the rest of the harvest is a large amount of "rice straw". Plow instead of burning rice stubble take a long time (Suansokchaug, Loatong, Malakham, & Kongmee, 2018). It is therefore inevitable that rice straw burning methods such as waste incineration are required, which in addition to destroying agricultural land structures, are also emitting carbon dioxide and destroying the atmosphere of the world eventually leading to global warming (Intan, Leng, Kami, Sukkaew, & Jaaoh, 2017). At the end of the farming season, most of the female farmers have a career in silk weaving. From the study of silk fairs in Surin province, it was found that the problem that Surin people were facing was foreigners produced silk that imitates ancient patterns for sale. By those patterns that had been modify in the newly created pattern, the Surin silk producers faced a significant problem, namely copying and modifying patterns on silk fabrics from both Surin local and foreign producers, included foreign producers. Surin silk work might be in a lagging state, exhibited by the lack of development of patterns and product designs (Sirisakbunjong & Tamisanont, 2011). From the study of policy data in various government sectors, it was found that the Institute of Textile Industry Development the Ministry of Industry aims to accelerate the Thai textile industry towards Thai Eco fiber used pineapple leaves, hemp plants, silk thread scraps and waste materials from the agricultural and

industrial sectors to wove into prototype fabrics and processed them into products for daily used. The value of Thai natural fiber exports in 2013 was 24,353.65 million baht, increased of 6.9 percent from the previous year, while synthetic fiber exports were worth 5,731.65 million baht, grew by 4.55 percent, indicating an increased demand for natural fiber consumption. The innovation development and personnel research with the aim of research was capacity development. In the national competition and self-reliance, using the scientific and technological knowledge base in a balanced and appropriate manner, and to focus on research to build knowledge and expand the wisdom of the country and the public, as well as to strengthen the research capacity of the country.

The research and development of rice straw fibers mixed with silk fibers from cocoons were brought to the development of textiles for the development of fashion and lifestyle products: case study of Khwao Sinarin sub-district Khwao Sinarin district Surin province with the objectives to: 1) analyze the research and test the fiber composition of the type Kor Khor-15 rice straw, 2) study the properties of the yarn produced from rice straw fiber mixed with cocoon fiber by using the knowledge gained from studying the wisdom of yarn production fiber strength, size and the elongation fibers, 3) design unique silk ikat patterns in Khwao Sinarin, 4) design contemporary clothing products from woven ikat silk cloth woven with rice straw fibers mixed silk cocoon fibers.

Materials and Methods

1. Studying the documents and research related to the development of Kor Khor-15 rice straw fiber. The rice straw fibers digestion was by chemical and enzymatic methods. (Narkchamnan & Krongtaew, 2012).



Figure 1 Digestion of Rice Straw Fibers was by Chemical and Enzymatic Methods.

Source: Photographed by Researcher.

2. Experiment to create rice straw fibers mixed silk cocoon fibers of the prototype. Surin province had a self-established colony to grow mulberry and raised silkworms type Saraburi yellow silk in Kap Choeng district. That was used in the Thai silk industry that had a handcrafted silk processing process starting from the purchase of fresh cocoons to silk threads production for sale. Therefore, there were many silks left over from the silkworm factory. For this reason, the innermost cocoon of type Saraburi yellow silk is used as fiber. For this reason, the fibers from the cocoons (a) spun into twine together with rice straw fiber using the production of fibers in the traditional form of spinning with a spinner (Knitting machine) (b) (Jankaew, Seo, & Khiaomang, 2019) until the birth of yarn made from rice straw fibers mixed with cocoon fiber (c).

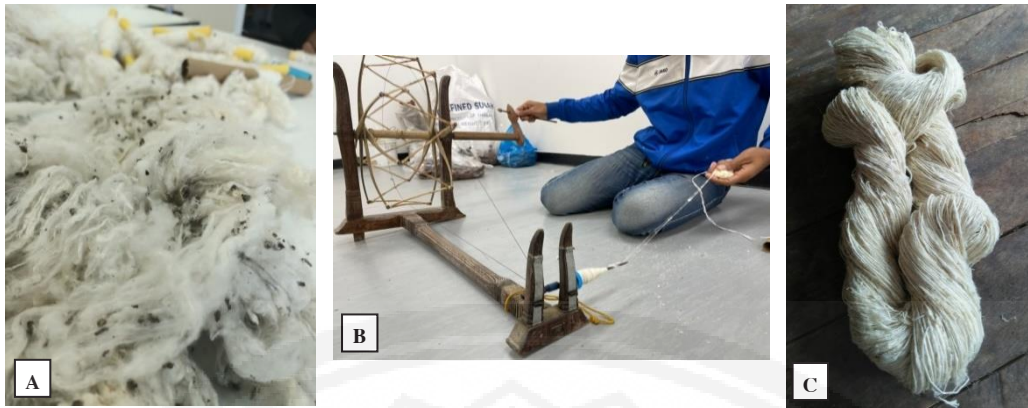


Figure 2 The Spinning Process of Rice Straw Fibers Mixed with the Original Silk Cocoon Fibers.

Source: Photographed by Researcher.

3. Studying, analysing, and testing the fiber composition of the Kor Khor-15 rice straw in the area of village 2, Khwao Sinarin sub-district Khwao Sinarin district Surin province and testing the physical properties of yarns in terms of fiber strength, fiber elongation and the toughness of the fiber.

4. Qualitative Research Method was conducted in 2 steps as follows:

4.1 **Step 1** Carrying out survey research by studying information from documents was evidence and outstanding work of Khwao Sinarin sub-district silk weaving group using research data gathering methods such as observation and interviews.

4.2 **Step 2** Carrying out research and product development using research data collection methods to ikat silk patterns and contemporary clothing products from woven ikat silk with rice straw fibers mixed silk cocoon fibers.

Results and Discussion

1. The study results of physical data and chemical composition of rice straw. The analysis of the rice straw of Kor Khor-15 showed the fiber content (%). Table 1 reported that the average percentage of Kor Khor straw fi-15, the NDF was 71.17%, the ADF was 44.31%, the ADL was 3.00%, the cellulose was 41.30%, and the hemicellulose was 26.66%. This composition was close to the one reported by (Maduang, Chunchachart, & Pawongrat, 2018). The percentage of cellulose tissue of water hyacinth was 24.25% (Piakong, 2014). The composition fiber content of palm bunch had highest hemicellulose at 33.85%, 52.43% cellulose and 4.82% lignin whereas the rice straw of Kor Khor-15 had higher percentages of cellulose and hemicellulose than water hyacinth but similar to the fibers from the palm bunch. It was shown that straw fibers had basic chemical properties which might be suitable for the production of textile fibers. In addition, almost the entire area of Surin province was rice cultivation and was also the main occupation of the people in the province (Suansokchaug et al., 2018). The cultivation of the Kor Khor-15 rice had a short harvesting period, achieving rapid harvesting and producing large amounts of rice straw. Cellulose properties in natural fibers were able to absorb moisture well, made it comfortable to wear, the woven fabric had easy to maintain. As a result of these properties, rice straw fiber might be an alternative for the wider variety of silk producers.

**Table 1** Analysis of Fiber Content of Rice Straw Kor Khor-15 Species in the Area of Village 2 Khwao Sinarin Sub-district Khwao Sinarin District Surin Province

| Rice Variety | Fiber Content (%) | | | | |
|----------------------------|----------------------------------|-------------------------------|--------------------------------|--------------|---------------|
| | Neutral Detergent Fiber (NDF) | Acid Detergent Fiber (ADF) | Acid Detergent Lignin (ADL) | Cellulose | Hemicellulose |
| Kor Khor-15 Rice Straw (1) | 69.71 | 43.42 | 3.15 | 40.27 | 25.75 |
| Kor Khor-15 Rice Straw (2) | 71.46 | 44.69 | 3.02 | 41.64 | 26.77 |
| Kor Khor-15 Rice Straw (3) | 71.97 | 44.67 | 3.06 | 41.61 | 27.03 |
| Kor Khor-15 Rice Straw (4) | 71.56 | 44.47 | 2.79 | 41.68 | 27.09 |
| Total | 284.7 | 177.25 | 12.02 | 165.2 | 106.64 |
| Mean | 71.17 | 44.31 | 3.00 | 41.30 | 26.66 |

2. Properties analysis of the yarn produced from rice straw fiber mixed with cocoon fiber. From the statistical analysis was found that the yarn made from rice straw fiber mixed with cocoon fiber had the mean strength of 184.16 newton. The mean elongation was 58.68 mm or equal to 5.868 cm. The mean toughness was 2.24 cN/T. The average elongation rate was 11.73%. The mean time to test was 11.90 s. The mean elongation strength was 138.83 N (Table 2), this was in the same range as reported by Papatana, Ritnim, Sawanaporn, & Maud-ew (2010) where the mean value of the strength of the lotus leaf stalk of Queen species was 143.218 newton. (Ariyakuare, 2011) reported that the mean elongation of the cocoon and hemp blended yarn was 2.30 cm. Mixed with cotton fibers was 2.32 centimeters. Mixed with ramie fibers was 2.77 centimeters. Mixed with linen fibers was 3.42 centimeters. Mixed with pineapple fibers was 3.43 centimeters. The yarns made from rice straw fiber mixed with cocoon fiber had high content of the cellulose fiber, which made the yarn had high strength and good elongation but the fibers from rice straw were short fibers when dyed and washed process, the rice straw fibers would be loosened which must be studied and developed in terms of the durability of the fibers in the next order.

Table 2 Characteristics Analysis of the Yarn Produced from Rice Straw Fibers Mixed with Cocoon Fibers

| Level | Strength F (cN) | Elongation I (mm) | Tenacity D (cN/T) | Elongation Rate E (%) | Time T (S) | Strength at Specified Elongation F (cN) |
|-----------|--------------------|----------------------|----------------------|--------------------------|---------------|--------------------------------------------|
| Average | 184.16 | 58.68 | 2.24 | 11.73 | 11.90 | 138.83 |
| Max Value | 196.00 | 64.29 | 2.39 | 12.85 | 13.04 | 115.00 |
| Min Value | 175.50 | 50.85 | 2.14 | 10.17 | 10.32 | 135.00 |
| STD | 10.61 | 6.99 | 0.13 | 1.39 | 1.41 | 5.39 |
| CV (%) | 5.76 | 11.91 | 5.80 | 11.84 | 11.84 | 3.88 |

3. The study results of the unique ikat silk design guidelines of Khwao Sinarin sub-district Khwao Sinarin district Surin province. The research reported on the identity of Khwao Sinarin by studying the following sources of information:

3.1 Collecting information from books and researches from documents, evidence and outstanding works of Khwao Sinarin sub-district which exhibited that the most prominent piece of Khwao Sinarin was the Takao, a type of silver engraved jewelry with flower-like patterns used as earrings. When viewed from the front, it was circular in shape, the radius ranges from small to large and was shaped like a triangle spreading out into a circle (a) when viewed from the side, Takao had a cone shape. They were curved to wear as earrings (b) The research from (Punyano, 2011) reported the local handicraft of Khwao Sinarin made of Takao silver accessories, the only



place in the world as the occupation of local people (Tongsupon & Pinitdankang, 2017) which matched with inspiration from Khwao flower, the symbol of the district that looked like a circle and had lines spread out around the radius.

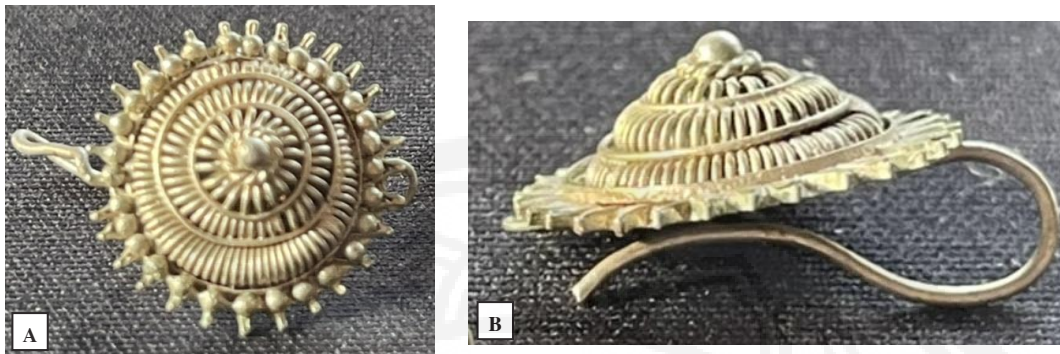


Figure 3 Example of Silver Accessories in the Type of Jewelry from Khwao Sinarin Sub-district Khwao Sinarin District Surin Province.

Source: Photographed by Researcher.

3.2 An interview, Mrs. Poonsook Thuechalad, the chairman of the woven silk group of village 2 Khwao Sinarin sub-district revealed that a unique identity was Khwao flowers. In the past, there were many trees so that the originated name from Khwao Sinarin sub-district. The word “Khwao” pronounced as “Khwa-Wao” was a type of perennial plant that had longevity. It was often used as an auspicious instrument.



Figure 4 Khwao Flower.

Source: Khwao Sinarin Community, 2019.

3.3 The concept design of the unique ikat silk pattern of Khwao Sinarin sub-district Khwao Sinarin district Surin province reflected the identity of Khwao Sinarin made it possible to convey factual and abstract concepts as follows: 1) Takao silver accessories, the factual aspect was featured in a circular shape that imitated blooming flowers by repeating beautiful pattern placement, embossed, fluted, colorful, shiny silver and matt black silver. The abstract aspect was a sacred item. If you had it by yourself, it would bring you peace of mind, prosperity and happiness, 2) Khwao flower. The factual aspect had a distinctive shape in a circular shape with pollen scattered throughout the flower. The abstract aspect were auspicious events to bring prosperity and happiness.

The research reported that the silk weaving group in village 2 Khwao Sinarin sub-district prefer to weave traditional patterned silk ikat cloth. A popular pattern of silk ikat tie, small wire pattern, was a patch of pattern according to the weaver's imagination, inspired by the surroundings in a natural pattern and objects such

as ikat silk with Mimusops flower pattern (a) ikat silk with watered-silk pattern or Hol pattern (b) nowadays, there are applications of weaving white silk (c) changing the color to contemporary that is consistent with the research of (Phayakprakhon, 2016) who reported that Khwao Sinarin district had good quality of local hand-woven silk in the province. Used harmonious color pairs and inserted a pair of contrasting colors. This was consistent with the research of (Klangrit, 2019) who reported that weavers used their creativity to design patterns created from the surroundings or objects that are used in their everyday life. The choice of silk threads or silk threads was a result of growing mulberry silkworms, required a large amount of land for cultivation and a long period of time for raising. Causing the weavers could not grow their own mulberry silk. In the part of patterns creation, it had been passed on since the ancestors and weavers including their descendants had not successors or studied in design. Due to life style, society and environment had resulted that had not developments in patterns, colors and a wide variety of fibers.

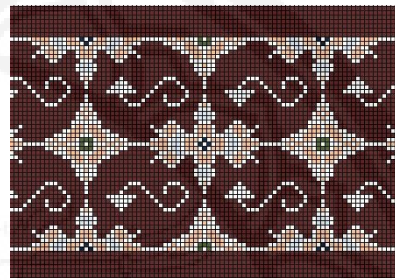


Figure 5 Example of Silk Ikat Cloth from Khwao Sinarin Sub-district Khwao Sinarin District Surin Province.

Source: Photographed by Researcher.

3.4 The basic concept of ikat silk design from the inspiration of Takao silver accessories and Khwao flower. The designer began by combining images of Takao silver accessories, Khwao flowers and ikat silk to create a harmonious combination sketch and bring each unit was taken to design a motif using the principle of unity to form a pattern in the whole and maintain the uniqueness of using a harmonious pair of colors (a) reproduction of Takao silverware, Khwao flowers and ikat silk and brought each unit to designed and created a ikat silk motif used the principle of unity to create a pattern in the whole picture and took into account the principle of balancing by used the principle of equilibrium (symmetry balancing). It was a pattern design by cutting the pattern, transformed it by mixed the sequence, alternating left and right, and rotating around the points (Reflection, Rotation and Translation) to create a new pattern. Set two or more different pattern units to be arranged in a repetitive but different pattern. Arranged the rhythm of each unit to be continuity and resulting in a unified link, brought motifs to be arranged horizontally in rows until the end of the workpiece, combined the identity of the district's ikat silk. Therefore, ikat silk was a patch point, leaving spaces, strung together until it becomes the shape of each unit of pattern according to the pattern that had been designed. Used a harmonious pair of colors. using adjacent colors, using 2 to 3 colors that are closely related in the color band: yellow, red, brown (b) close to those reported by (Pleawjit, 2019) who reported that the processing of plant fibers and their development into textiles should be adapted and developed from old patterns that were simple but elegant or unique to the local area, which gave them a distinctive point was different from weaving in other places. In the production should focus on the beauty and meticulous craftsmanship in weaving to created value and to added value to the piece. A prototype product development should focus on the needs of the new generation. and could be used in a wide variety of products close to that reported by (Nithithongsakul, 2018) reported that brought the silk waste from the silk milling process

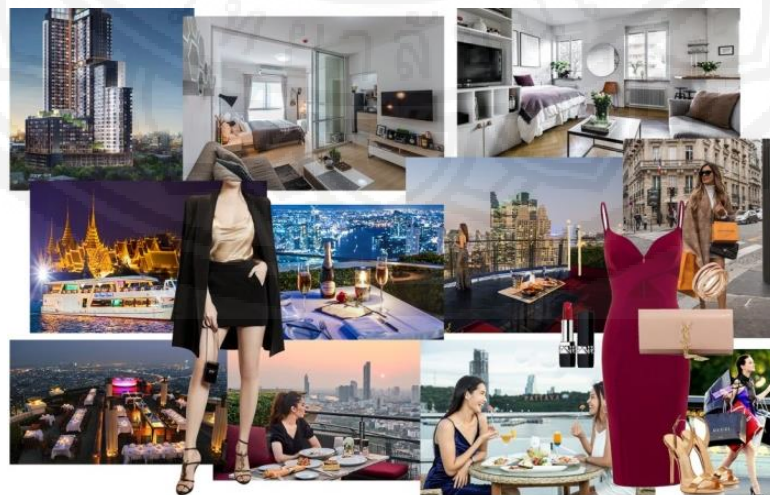
The Concept of Silk Ikat Pattern Design Inspired by Takao Silver Accessories and Khwao Flower



Designed Silk Ikat Pattern Inspired by Takao Silver
Accessories and Khwao Flower

Source: Photographed by Researcher.

Researchers had studied the design guidelines for modern clothing by studying the sources of books and research reported create a product image to determine the design concept by studied the trend of developing clothing products was consistent and popular in 2021. In order for products that were design in a direction that was suitable for consumers, we seek inspiration for clothing, housing, in accordance with the target group and way of life by:



Source: Photographed by Researcher.

Propagation designs through a silhouette H-Line which the wearer's body-fitting frame was not too slim nor too loose (a) the draft was therefore designed to suit the target group's daily life. Using silk fabric patchwork techniques with a color close to the ikat silk cloth, taking into account the size and proportions. Highlights were in placing ikat silk cloth, consisted of suits, pants, kimono shirts, dresses (b) and sewing into clothing products made from rice straw fibers mixed from the original silk cocoons (c) related (Thumrongchot, 2019) who reported that consumer behavior towards local textile products. Most of the consumers of the product were females. Most buyers of this product were of the view that clothing products should be sold individual blouses and pants or blouses and skirts, that used a monochrome color or harmonious colors. Therefore, the design was based on the concept of life style inspiration combined fashion styles to developed textiles to extend lifestyle fashion products until abled to developed competitiveness used waste materials from agriculture and industry to woven into prototype fabrics and process them into products for daily used, so the new generation of people with stylish clothes could show clear identity focus on comfort, simple and capable of purchasing power to maintained the value of pride in Thai culture.



Figure 8 Clothing Structures Used in the Contemporary Clothing Products Design.

Source: Photographed by Researcher.



Figure 9 Sketch of Contemporary Clothing Products.

Source: Photographed by Researcher.



Figure 10 Clothing Products from Rice Straw Fibers Mixed with Fibers from the Original Cocoons.

Source: Photographed by Researcher.

5. The results of the development clothing products from rice straw fibers mixed silk cocoon fibers and the satisfaction of the entrepreneurs related to clothing manufacturers.

The researcher reported that the development of clothing products from rice straw fibers mixed with silk fibers from the prototype cocoon had results in assessing the satisfaction of the sample groups on the form and application of the product. The hypothesized analysis resulted from the test score of full satisfaction at level 5.00 had the passing score threshold at 3.50 points. The results of the assessment were obtained from the following list: the comfortable to wear and good texture was at 4.3 level, the involvement with ECO consumed products was at level 4.2, and the purchased product decision was at 4.1. When this was compared to dresses, kimonos and pants. It showed that the sample's satisfaction was at a high level. The researcher presented the real prototype and transferred the production technology, including the real production prototype to the silk weaving group of village 2 Khwao Sinarin district. Bringing the knowledge of co-fashion and textile design brought people in the community ranging from community sages who specialized in fabrics and textiles, old people who still had a weaving lifestyle and new generations who wanted to bring their existing cultural capital to add value to products in the community. All these processes resulted in a collaboration between the research team and villagers to develop contemporary fabric patterns. The product was convenient to use and easy to distribute as well as making people in the community love and cherish what their ancestors had created, resulting in a sustainable community. From this reason, the clothes products development from rice straw fibers mixed silk fibers, it had given important to the fibers production that were truly local materials then designed patterns from the identity of the district woven used the community's cultural capital in ikat silk technique then further by processing into clothing products from rice straw fibers mixed cocoons fibers to created identity and added value to products in the community.

Conclusion

Composition of the Kor Khor-15 rice straw in the area of village 2 Khwao Sinarin fiber contain Cellulose was 41.30%. The properties of the yarn produced from rice straw fiber mixed with cocoon fiber had a high mean of strength and elongation. The unique silk ikat pattern design in Khwao Sinarin basic concept was started by combining images of Takao silver accessories and Khwao flowers to create a harmonious combination. The design and motif were created using the principle of unity to create the overall pattern taking into account the principle of



balance. Brought each unit to design and create ikat silk motif used the principle of unity as a pattern design by cutting the pattern. It was transformed by a combination of sorting, alternating left-right and rotation around points (Reflection, Rotation and Translation) to create a new pattern. Set two or more different pattern units to be arranged in a similar fashion but with different patterns. Arranged the rhythm of each unit so that it is continually connected to create a unified connection. Brought the motifs to be arranged in horizontal rows until the end of the piece combines the identity of the district's ikat silk. Therefore, ikat silk was a patch point, leaving spaces, strung together until it was becoming the shape of each unit of pattern according to the pattern that had been designed. Using a harmonious pair of colors by adjacent colors that were 2-3 similar colors in the color circle: yellow, red and brown. Weaving the original fabric with the silk ikat technique that had been designed using the yarn as a weft and warp threads. Studying the design of contemporary clothing products from woven ikat silk cloth with rice straw fibers mixed cocoon fibers, it was found that clothing products development from rice straw fibers mixed cocoons fibers had given importance to the fibers production that used materials from waste materials from the agricultural and industrial sectors then designed patterns from the identity of the district. Woven used the community's cultural capital in ikat silk technique, continuing with the transformation into fashion and lifestyle clothing products from rice straw fibers mixed cocoons fibers to created identity and added value to products in the community. The results of the assessment from the following list comfort, good texture, engagement with ECO product consumption and product purchasing decisions. The satisfaction of the sample was at a high level of satisfaction abled to develop competitiveness in weaving into prototype fabrics and transformed them into products for daily used by expanded wisdom technology to commercial innovation for sustainable self-reliance of the community.

Acknowledgements

This research was funded by a grant from the area administration and development grant management unit. Office of the Higher Education Science Research and Innovation Policy Council Annual, fiscal year 2020.

The authors would like to thank Mr. Sompong Thuechalad, the municipality's president of Khwao Sinarin sub-district municipality, Mr. Sanerchai Kongsakul, head of Khwao Sinirin sub-district. Mrs. Poonsook Thuechalad, chairperson of the silk weaving group of village 2 Khwao Sinarin sub-district and all group members for contributing information as well as facilitating the visitation throughout the research work.

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