



DOI: [https://doi.org/10.71317/kjard.2.8\(s\).2026.699](https://doi.org/10.71317/kjard.2.8(s).2026.699)

Kashmir Journal of Academic Research and Development



Bio-Hybrid Materials Innovation for Batik: Thermal Characterization and Phase Behavior of Soya-Paraffin Wax and Bees-Paraffin Wax Mixtures

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ARTICLE INFO

ABSTRACT

Received:

July 01, 2026

Revised:

July 22, 2026

Accepted:

August 05, 2026

Available Online:

August 25, 2026

Keywords:

batik, soya wax, bees wax, recipe, paraffin, temperature, comparison, performance, degree.

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Batik is a procedure to beautify the surface of the fabric with the help of wax covered patterns such as figures, floral, geometric and abstract with the help of unique addition of wax solution throughout the process.

The focus of the study was the utilization of blends of (soya with paraffin wax) & (Bees wax with paraffin wax) number of experiments were performed and tested to attempt and accomplished the ideal accurate degree /temperature, of wax specifically for wax molten state.

Wax was melted by two methods, through a double boiler system & direct heat to observe and maintain the correct temperature of hot liquid and double boiler system was considered as recommended.

Measurements regarding suitable temperatures and melting points were also recorded for Soya wax and Beeswax.

Comparison of Bees & Soya wax was tested and proved that soya & bees both waxes were better for the technique to maintain durability and performance, of batik technique.

Tabulation detailed descriptions were adopted to clarify and present the attempted results for the results samples.

Introduction

What is Batik?

Batik is the craft of wax–safe colour on textures to make wonderful and beautiful plans. This customary strategy for colouring is continued in nations like Indonesia, Sri Lanka, India, Nigeria, Malaysia, Singapore, Japan and China. Indonesian batik, rehearsed in the island of Java, is the most popular on the planet and holds the mastery of workmanship, quality, methods, and examples.[5] Batik isn't simply material, however Indonesian writing in each plan and theme holds 1,000,000 methods of reasoning and profound implications. Indonesia has an assortment of batik that keeps on being saved.[3]

Batik is considered to be the Nationalism of Indonesia. As it is understood that batik is a cultural heritage of Indonesia and they have range of themes and design statements in it according to the areas. And Indonesia earn capital as well from batik. The Indonesian maximum areas craft men utilize their time and energy in entrepreneurship among different countries and states. When batik got recognized worldwide as Indonesian cultural heritage in 2009, Suddenly Malaysia claimed the owner ship of the craft and spared rumours on social media that it's the craft and culture of Malaysia after that Indonesian government took decision and declared that Batik is the Art, Craft and cultural heritage of Indonesia and it is not the culture it is a method of depicting and narrating the native stories and traditions to the nation. They decided to preserve batik and believe, further make others believe that Batik is the dignity and identity of Indonesia.[4][5]

Numerous Indonesian batik designs are emblematic. New–born children are conveyed in batik slings finished with images intended to bring the youngster karma, and certain batik plans are held for ladies and husbands, just as their families. During the frontier time, Javanese courts gave orders that directed certain examples to be worn by an individual's position and class inside the general public. Ruler Hamengkubuwono VII, who governed the Yogyakarta Sultanate from 1921 to 1939, saved a few examples, for example, the Parang Rusak and Semen Agung for individuals from the Yogyakarta eminences and limited ordinary people from wearing them. Batik articles of clothing assume a focal part in certain Javanese ceremonies, like the stately projecting of illustrious batik into a spring of gushing lava. In the Javanese naloni mitoni function, the mother–to–be is enveloped by seven layers of batik, wishing her beneficial things. Batik is additionally conspicuous in the tedak siten function when a kid contacts the earth for the first time. Contemporary practice regularly permits individuals to pick any batik designs as per one's taste and inclination from easygoing to formal circumstances, and Batik producers frequently adjust, consolidate, or concoct new emphases of notable examples. Explicit example necessity are regularly held for customary and stately contexts.

In October 2009, [5] UNESCO assigned Indonesian batik as a Masterpiece of Oral and Intangible Heritage of Humanity. As a feature of the affirmation, UNESCO demanded that Indonesia save its heritage. The day, 2 October 2009 has been expressed by Indonesian government as National Batik Day, as likewise at the time the guide of Indonesian batik variety by Hokky Situngkir was opened for public interestingly by the Indonesian Ministry of Research and Technology.[5]

What is a Wax?

Waxes are organic compounds that characteristically consist of long aliphatic alkyl chains, although aromatic compounds may also be present. Natural waxes may contain unsaturated bonds and include various functional groups such as fatty acids, primary and secondary alcohols, ketones, aldehydes and fatty acid esters. Synthetic waxes often consist of homologous series of long-chain aliphatic hydrocarbons (alkanes or paraffin) that lack functional groups.[5]

a) Animal waxes

Beeswax, produced by honey bees

b) Vegetable waxes

Soy wax, produced by soybean oil

c) Petroleum wax

Paraffin wax, produced by long chain alkane, Here Bio hybrid materials of three types of wax were used in the research for batik technique and that is animal wax as bees wax, vegetable wax as soya wax and petroleum wax as paraffin wax to check and text the thermal characteristics of the wax solutions. Where the behavior will be observed of the wax samples.

Review of Literature

Material and Methods

The study focuses on only two sets of waxes Soy–Soya wax and Beeswax and the combinations of each with Paraffin wax. Experiments performed on the base of Cotton fabric

Different degrees of waxes were measured to get an ideal and accurate degree temperature of wax molten state.

Objectives of the Research Study

1. To measure various degrees of temperature and time duration to get the best suitable solution
2. Comparison of Bees and Soya waxes characteristics
3. Collection of different samples of Soya wax and Beeswax to achieve the best suitable combination of wax with paraffin wax.

Significance of the Study

This study will help readers and students to accomplish successfully the important major & minor problems occurred during wax solution preparation.

Parameters

1. Calculate the suitable ratio of (Beeswax and Paraffin wax), starting from 20–80 percent
2. Calculate the suitable ratio of (Soya wax and Paraffin wax), starting from 20–80 percent
3. Calculate the suitable Temperature level by
 - a) Condition Direct heat system, Hot plate
Ideal suitable temperature level and time.
 - b) Condition Double–Boiler heat system
Ideal suitable temperature level and time.
4. Calculate the Melting point of 1st set of waxes i.e. (Beeswax & Paraffin wax)
5. Calculate the Melting point of 2nd set of waxes i.e. (Soy–Soya bean wax & Paraffin wax) to conclude the best, ideal melting point.

Materials and Tools

Waxes

Core wax characteristics

Wax	Nature / composition	General behaviour in batik
Soy wax	Hydrogenated soybean oil; mainly triglycerides (vegetable lipids).	Soft, creamy, flexible and relatively low–melting. Gives low crackle and can be easier to remove, but may be runny or less durable in hot dye baths if used alone.
Paraffin wax	Petroleum–derived mixture of long–chain saturated hydrocarbons (alkanes).	Harder, more crystalline and brittle. Promotes crackle and can give crisp effects, but excessive amounts may flake and allow dye to penetrate.
Beeswax	Natural mixture rich in wax esters, fatty acids and long–chain compounds.	Flexible, adhesive and cohesive. Produces smoother resist lines with less crackle than paraffin; can be sticky and more difficult to remove when used alone.

Wax total three (3) different waxes were used it the study i.e. Bees wax, Paraffin wax and Soy–Soya Wax

Pure Bees Wax (Animal wax)



Figure 1



Figure 2

Table 1:

Wax type	Density (g/cm ³)	Melting point (°C)
Beeswax	0.951	62–651

Properties of Bees Wax [13]

1. Bees wax is an animal wax
2. It usually comes in golden brown in colour
3. Shelf life is long last only change of colour occur and convert into dark brown
4. Melting point is 60–70°C
5. Wax application is possible only in liquid state
6. Beeswax gets cold in no time which create problem while batik technique
7. Strokes of wax can be noticed visibly on the fabric

8. Brush application is very hard due to the cold property of the wax
9. Very hard, thick on the surface of the fabric
10. Bees wax totally different effect of application on Cotton and Silk fabrics
11. Handling pure bees wax very hard to difficult
12. Weight of bees wax treated fabric becomes double times heavy
13. Not recommended to use pure bees wax for batik technique
14. Double boiler method (Pan on Pan) is ideal for batik
15. Direct heat (flame) may cause wax burn
16. Bad smell may occur while the process of batik
17. Removal of beeswax is difficult need 4to 5 hot water detergent washes for wax removal
18. Air permeability of the fabric gets effected.

Paraffin Wax (Petroleum wax)



Figure 3: Paraffin wax [5]



Figure 4: Paraffin wax [5]

Table 2:

Wax type	Density (g/cm³)	Melting point (°C)	Flash point °F (°C)
Paraffin wax	0.88–0.941,2	47–651	390 (198)1

Properties of Paraffin Wax [14]

1. Paraffin wax is a Petroleum wax normally available in white colour
2. Melting point of paraffin wax 46–61°C
3. Gets melt very easily
4. Not gets cold and harden [15]easily
5. Application of paraffin wax is possible only in molten form on fabric
6. Effect of wax application is very smooth
7. Easy to handle
8. Paraffin has a natural ability to create cracks–crystals which plays an ideal role in batik
9. Paraffin wax has different effect on Cotton and Silk fabric
10. Fabric gets light in weight after paraffin application
11. Suitable heating system is double boiler (Pan on Pan) method
12. Direct heat may cause flame and wax burning
13. Shelf life is long last should be keep in dry indoor areas
14. Removal of wax is easy with hot water and detergent wash
15. Fabric may lose its air permeability after batik application
16. Highly recommended for batik application

Soya – Soya Wax (Plant wax)**Figure 5**



Figure 6

Table 3:

Wax type	Density (g/cm ³)	Melting point (°C)	Flash point °F (°C)
Soy wax	0.9 g/ml.	120 to 160	170° F

Properties of Soy–Soya Wax [16]

1. Soya wax is white in colour
2. It has the quality of making crystals after it is applied and dried
3. Application is possible when wax is in liquid form
4. At a temperature of 149–158°F/45–53°C Soya wax gets melt
5. It can be easily washed by hot water and fabric detergents
6. Soya wax melts more quickly–easily and remain in molten state for longer time
7. Easy and smooth while application on pure Cotton and Silk fabrics.
8. Batik Tools and brush both can be utilized for wax application
9. Weight of fabric is very light after wax application on Cotton and Silk fabrics
10. Availability is easy via online wax dealers
11. Economical in cost, available in small flakes and cubes as well
12. Shelf life is excellent one can reused it many times just need to store in a glass jar with a covered head otherwise dirt may catch the wax, which might change the colour of the wax
13. May Heat by a double boiler method (pan on pan)
14. Direct heat may also be used but make sure about the flash point, should not be heated too much

15. Direct flame heat and repeated heating may cause change in the colour, but does not affect the batik process performance at all
16. Best suitable for batik technique due to its easy application and wax removal
17. You may find different effects of wax cracks–crystals on cotton and silk fabrics

Fabrics

Base materials (Background Fabrics) of Batik

We use variety of fabric for batik but the most suitable and ideal fabric, Cotton and Silk Cellulosic fabric were utilized in the research.[14]

Best suitable base material for Batik

Standard and most fabricated materials are sensible for Batik strategy, Cotton, fabric is stunningly best fitting. Cotton is on the top because of its optimal condition on the whole perspectives it has best retentive penchant. Where wax ought to be hold in the surface base.[14]

Tools for wax liquefaction

1. Wax solution
2. Metallic saucepan OR cooking pot
3. Hot plate
4. Gas burner medium size
5. Disposable cups for dye mixture
6. Polka sticks for mixing purpose
7. Apron, face mask and gloves
8. Match box, napkin,

Hazard and Precautions

No such hazard was noticed while working in wax regarding inhaling and respiration. Main precaution should be taken care of, while working on direct flame keep the flame on medium to avoid fire, because wax catches fire in no time.

Comparison of Soy-wax and Beeswax

Table 4: Comparison of Soya and Bees both waxes with Paraffin wax on Cotton Fabric

Soy-Wax with Paraffin on Cotton fabric	Bees wax with Paraffin on Cotton fabric
Smooth brush application	Hard brush application
Ideal tool application	Not ideal for tool application
Easy wax removal	Hard wax removal
Maximum Air permeability	Minimum Air permeability
Ideal crackle effect	Normal cracks
Ideal wax absorbency in fabric	Hard wax absorbency in fabric
Light weighted Fabric	Heavy weighted Fabric
Remain in molten time for long time	Gets cold quickly
No smell botheration	Smell botheration

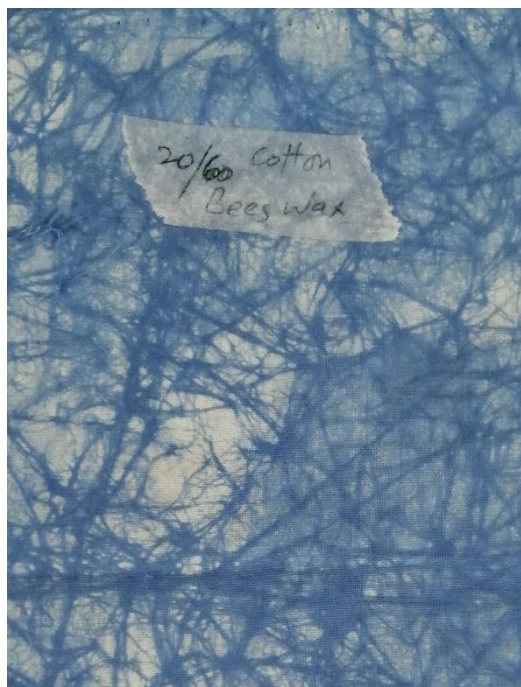


Figure: 6 (20/60) Bees wax, Cotton sample



Figure: 7 (20/40) Soya wax Cotton sample

Results of the Ideal Degree of temperature by Hot plate (direct heat) Where the sample size of wax was already adjusted in grams.

Results of Bees and Paraffin wax on Cotton Fabric Direct heat by Hot plate

Table 5: Various Wax Samples Size scale 20 Grams Paraffin Wax

S.NO.	WAX BLENDS	SCALE IN GRAMS	MELTING POINTS
1	Bees wax	20	60–70°C
2	Bees –Paraffin	20/20	70–75°C
3	Bees –Paraffin	20/40	75–80°C
4	Bees –Paraffin	20/60	80–85°C
5	Bees –Paraffin	20/80	80–85°C



Figure: 8 Molten state of Bees wax and Paraffin wax

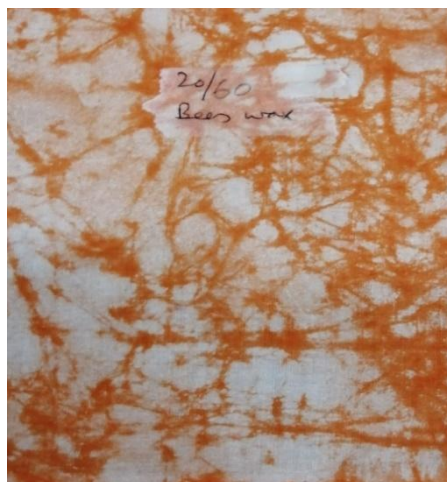


Figure: 9 (20/60) Bees wax Cotton sample

Result Conclusion

Cotton Fabric

Result noticed that the wax scale size of bees wax and paraffin wax is 20/ 60 with maximum crystal formation and smooth application on the Cotton fabric.

Results of Soy and Paraffin wax on Cotton Fabric Hot plate (direct heat)

Where the sample size of wax was already adjusted in grams.

Table 6: Various Wax Samples, Size scale 20 Grams Paraffin Wax

S.NO.	WAX BLENDS	SCALE IN GRAMS	MELTING POINTS
1	Soy–Soya wax	20	60–75°C
2	Soy –Paraffin	20/20	70–75°C
3	Soy –Paraffin	20/40	70–80°C
4	Soy –Paraffin	20/60	70–85°C
5	Soy –Paraffin	20/80	75–85°C



Figure: 10 Molten state of Soya wax and Paraffin wax

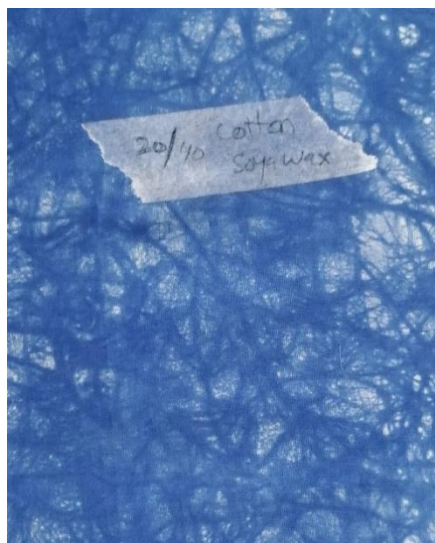


Figure: 11 (20/40) Soya wax, Cotton sample

Result Conclusion

Cotton Fabric

Result noticed that the wax scale size of Soya wax and paraffin wax was 20/40 with minimal crystal formation and smooth application on the Cotton fabric.

Results of the Ideal Degree of temperature by Double boiler (Pan on Pan) heating system where the sample size of wax was already adjusted.

Results of Bees and Paraffin wax on Cotton Fabric by Double boiler (pan on pan) heating system

Table 7: Various Wax Samples, Size scale 20 Grams Paraffin Wax

S.NO.	WAX BLENDS	SCALE IN GRAMS	MELTING POINTS
1	Bees wax	20	60–65°C
2	Bees –Paraffin	20/20	60–70°C
3	Bees –Paraffin	20/40	70–75°C
4	Bees –Paraffin	20/60	70–75°C
5	Bees –Paraffin	20/80	70–75°C



Figure 11: Double boiling heating process, Bees wax

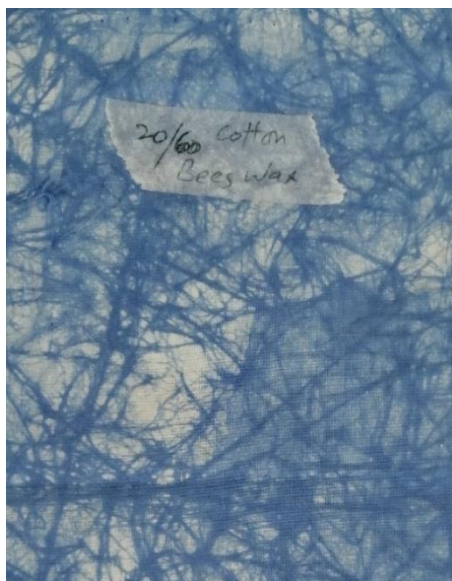


Figure: 11 (20/60) Beeswax, Cotton sample

Result Conclusion

Cotton Fabric

Result noticed that the wax scale size of beeswax and paraffin wax is 20/ 60 with maximum crystal formation and smooth application on the Cotton fabric.

Results of Soy and Paraffin wax on Cotton Fabric by Double boiler (pan on pan) heating system

Table 8: Various Wax Samples, Size scale 20 Grams Paraffin Wax

S.NO	WAX BLENDS	SCALE IN GRAMS	MELTING POINTS
1	Soy–Soya wax	20	70–75°C
2	Soy –Paraffin	20/20	70–80°C
3	Soy –Paraffin	20/40	70–85°C
4	Soy –Paraffin	20/60	70–85°C
5	Soy –Paraffin	20/80	70–85°C



Figure: 12 Double boiling heating system, Soya wax



Figure: 13 (20/40) Soya wax, Cotton sample

Result Conclusion

Cotton Fabric

Result noticed that the wax scale size of Soya wax and paraffin wax is 20/40 with minimal crystal formation and smooth application on the Cotton fabric.

Blend comparison for batik

Property	Soy—paraffin	Beeswax—paraffin	Soy—beeswax
Crackle potential	Moderate to high when paraffin-rich.	High and well-established; highly adjustable by ratio.	Low to moderate; generally smoother.
Line sharpness	Moderate; depends strongly on temperature and soy content.	Good; beeswax improves adhesion and continuity.	Good to very good when beeswax is sufficient.
Flexibility	Improves as soy increases.	Improves as beeswax increases.	Generally high, especially in soy-rich blends.
Dye-bath stability	Potentially lower in soy-rich blends; validate with testing.	Usually reliable, especially at balanced ratios.	Improves as beeswax content rises.
Wax removal	Usually easier than high-beeswax blends.	Paraffin-rich blends are usually easier to remove.	Soy may ease removal; high beeswax may need more thorough boiling/ironing.
Best aesthetic	Experimental, moderate crackle.	Traditional batik and intentional crackle.	Clean, flexible, low-crackle resist.

Conclusion

Wax ratio, comparison (cotton)

1. Resulted scale size of Bees wax and paraffin wax for cotton is 20/60.
2. Resulted wax scale size of Soya wax and paraffin wax for cotton is 20/40.

3. The results further concluded that paraffin–soya show that increasing soy content reduces tensile strength, stiffness and melting point. This supports the expectation that soy–rich blends will be softer and less crack–prone than paraffin–rich blends.
4. Soya wax with the combination of paraffin can be considerable for batik technique especially for intricate motives application as the crake effect of the ratio of 20/60 and 20/40 for cotton are perfect.
5. **Degree and temperature:** Whereas the degree temperature is concern (70–85) degree is ideal for cotton where the molten set of wax is (Soya –Paraffin OR Bees –Paraffin).
6. **Heating system:** It is further concluded regarding the heating method that double boiling system is recommended and best suitable because it can easily maintain the molten state of wax for a longer period of time due to the boiling water kept underneath.

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