

# The Gloves as Effective Personal Protective Equipment (PPE) of Indonesian Batik Workers

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## Abstract

**Background:** Batik substances may increase the risk of biological function disruption to batik workers.

**Objective:** To Determine the effectiveness of using test gloves in transepidermal water loss (TEWL), skin hydration level, and skin acidity (pH).

**Methods:** This study was one group pretest-posttest design of 16 batik workers. Subjects use test gloves made from neoprene on right hands and personal gloves made from thermoplastic polymer of vinyl chloride on left hands in first and second week. Washed out for 2 weeks, last 2 weeks use test gloves on left hand and personal gloves on right hand. TEWL, skin hydration level, and pH was examined by Cutometer dual MP-580

**Result:** First and second week using test gloves on the right hand, significantly differences of TEWL level on extensor and dorsum manus; skin hydration level on flexor, extensor, palmar, and dorsum manus; pH on extensor, palmar and dorsum manus ( $p < 0.05$ ; CI 95%). Fifth and sixth week using test gloves in the left hand, significantly difference of TEWL level on dorsum manus, all area of skin hydration level and pH results ( $p < 0.05$ ; CI 95%). No significant differences of comparison right and left hand in the first, second, fifth, and sixth week, that showed any types of gloves can protect batik workers from skin barrier disruption.

**Conclusion:** Personal gloves and test gloves usage for protection doesn't have much significant difference. Wearing gloves may also give risk to trigger contact dermatitis if not used properly or using incompatible material.

**Keyword:** gloves, Indonesian batik workers, skin barrier function

## Introduction

Batik was declared as Masterpieces of the Oral and Intangible Heritage of Humanity by UNESCO on October 2, 2009. Furthermore, Yogyakarta was named

as "World's Batik City" by the World Craft Council (WCC) in 2014 because it fulfills the criteria for historical, cultural, preservation efforts and generation transfer, economy, environmental care, international reputation and sustainable commitment values. Apart from Java island, Madura, which is located adjacent to Java, is an area known for hosting quite a lot of home batik centers. One of them is in Bangkalan Regency, to be precise the Paseseh Village in Tanjung Bumi District, is a Batik Center. Batik in this area has a characteristic of coastal batik which uses sharp and striking colors such as red, green and blue.<sup>1,2</sup>

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During the production of batik, synthetic dyes usage increases exposure to harmful pollutants such as heavy metals, suspended solids, or organic substances. These exposures might enter human's body through the skin and respiratory mucosa. That exposure can be contact dermatitis. Occupational contact dermatitis is the most common in occupational skin disease in developed countries for between 70% and 90%. The incidence in Europe reported that 0.5 to 1 per 1000 workers. In Indonesia, study that had been conducted by researchers in batik workers population in Yogyakarta shows that the contact dermatitis prevalence due to work is quite high (10.36%). This shows the importance of personal protective equipment (PPE) in batik workers.<sup>3-6</sup>

PPE is important to prevent contact dermatitis. One of the most important PPE item in batik industry is gloves, that is recommended when wet work is performed. The wearing of gloves may improve hydration and pH of the skin.<sup>6,7</sup> The purpose of this study was to determine the effectiveness of using test gloves which can provide protection for skin, especially for batik workers, from irritation due to long-term working.

### Methods

Sixteen female batik workers who were involved in dyeing process from batik center in Tanjung Bumi District, Paseseh Village were included as samples in this clinical trial. Inclusion criteria in this study were age 15-50 years, involved in dyeing process, and were willing to participate in this study. There were 2 types of gloves evaluated in this study. The first type was personal gloves (their own gloves that batik workers had worn, made from thermoplastic polymer of vinyl chloride). The second type was test gloves that made from neoprene. In the first 2 weeks, the subjects were asked to use test gloves on their right hands and personal gloves on their left hands. Daily usage of the gloves were 8 hours a day and they were changed every 3 days. Washed out period was conducted for 2 weeks, it was a period when subjects were given with no gloves. Finally, in the last 2 weeks the subjects were asked to use test gloves on their left hand and their personal gloves

on their right hand. At the beginning and end of each treatment clinical examination as well as skin biological function tests (TEWL level, skin hydration level and skin acidity) were conducted on both flexors, extensor, palmar, and dorsum of the hands. Biological function of the skin (TEWL level, skin hydration level, and skin acidity) was examined using Cutometer dual MP-580, the examination takes three times per examination and the final result is an average. Analysis will be carried out to compare skin function between batik worker who wore test gloves and personal gloves. The correlation between pre and post exposure of the right/left hand was analyzed by t dependent test, while the correlation between right and left hand was analyzed by independent t-test.

### Results

This study involved 16 batik workers who were involved at dyeing process as subjects. Subjects were both male and female, aged 15-50 years. The results for mean TEWL level on flexor, extensor, palmar, and dorsum of right hands that used test gloves on the first week of study were 27.99g/m<sup>2</sup>/h, 26.07 g/m<sup>2</sup>/h, 48.57 g/m<sup>2</sup>/h, and 40.78 g/m<sup>2</sup>/h, respectively; meanwhile mean TEWL level on flexor, extensor, palmar and dorsum of left hands that used personal gloves from the workers on the first week of study were 29.64 g/m<sup>2</sup>/h, 27.09 g/m<sup>2</sup>/h, 47.05 g/m<sup>2</sup>/h, 33.16 g/m<sup>2</sup>/h, respectively.

Skin hydration level measurement results on flexor, extensor, palmar and dorsum of right hands on the first week were 58.77 AU, 63.80 AU, 46.53 AU, and 63.93 AU, respectively, meanwhile on the left hands the results were 61.61 AU, 59.74 AU, 45.40 AU, and 61.88 AU, respectively. Furthermore, the skin pH measurement results on flexor, extensor, palmar and dorsum of right hands were 5.18, 5.22, 5.25, and 5.04, respectively; meanwhile on the left hands the results were 5.19, 5.25, 5.36, and 5.16, respectively (Table 1, Table 2).

On the second week after the use of test gloves on the right hands for two weeks, TEWL level results on flexor, extensor, palmar, and dorsum manus of left hands were 24.66 g/m<sup>2</sup>/h, 19.77 g/m<sup>2</sup>/h, 54.49 g/m<sup>2</sup>/h and 23.61 g/m<sup>2</sup>/h, respectively; meanwhile on the right

hands the results were 27.24 g/m<sup>2</sup>/h, 18.72 g/m<sup>2</sup>/h, 50.98 g/m<sup>2</sup>/h and 20.54 g/m<sup>2</sup>/h, respectively. Skin hydration level results on right and left hands flexors were 44.13 AU and 38.74 AU; extensor 35.38 AU and 37.06 AU; palmar 29.47 AU and 27.98 AU; and dorsum 36.67 AU

and 39.11 AU. The skin pH measurement on right and left hands' flexor were 5.37 and 5.40; extensor 5.49 and 5.43; palmar 5.81 and 5.83; and dorsum 5.51 and 5.51 (Table 1, Table 2).

**Table 1. Comparison of the test gloves on the right hand at first week,second week,fifth week and sixth week**

		First week		Second week		P	Fifth week		Sixth week		P
		Mean	±SD	Mean	±SD		Mean	±SD	Mean	±SD	
TEWL level (g/m <sup>2</sup> /h)	Right Flexor	27.99	9.10	27.24	14.94	0.881	35.99	29.38	27.92	8.88	0.607
	Right Extensor	26.07	9.83	18.72	8.43	0.008	28.00	13.61	23.12	8.26	0.142
	Right Palmar	48.57	11.33	50.98	9.67	0.367	52.29	11.16	56.48	9.12	0.109
	Right Dorsum manus	40.78	10.25	20.54	8.54	0.000	35.91	11.08	30.84	10.17	0.073
Skin hydration level (AU)	Right Flexor	58.77	14.46	44.13	15.60	0.002	77.00	23.67	57.95	12.10	0.002
	Right Extensor	63.80	16.28	35.38	13.86	0.000	73.30	23.54	55.64	12.30	0.004
	Right Palmar	46.53	15.34	29.47	11.58	0.001	55.62	22.88	54.76	15.92	0.795
	Right Dorsum Manus	63.93	15.10	36.67	12.84	0.000	72.43	31.51	50.50	16.24	0.001
pH	Right Flexor	5.19	0.16	5.37	0.42	0.055	5.43	0.17	5.57	0.25	0.072
	Right Extensor	5.22	0.14	5.49	0.30	0.014	5.32	0.22	5.46	0.27	0.066
	Right Palmar	5.26	0.19	5.81	0.24	0.000	5.54	0.27	5.56	0.26	0.972
	Right Dorsum Manus	5.03	0.29	5.51	0.30	0.002	5.32	0.27	5.63	0.28	0.000

**Table 2. Comparison of their personal gloves on the left hand at first week,second week,fifth week and sixth week**

		First week		Second week		P	Fifth week		Sixth week		P
		Mean	±SD	Mean	±SD		Mean	±SD	Mean	±SD	
TEWL level (g/m <sup>2</sup> /h)	Left Flexor	29.64	14.36	24.66	13.65	0.191	26.80	15.58	27.53	12.21	0.917
	Left Extensor	27.09	11.92	19.77	12.04	0.039	27.31	11.89	22.06	6.47	0.093
	Left Palmar	47.05	12.11	54.49	9.20	0.050	53.18	11.16	56.67	12.19	0.127
	Left Dorsum manus	33.16	12.52	23.61	9.23	0.011	38.16	12.89	33.30	10.58	0.040
Skin hydration level (AU)	Left Flexor	61.61	19.25	38.74	11.03	0.005	70.66	21.11	56.66	13.65	0.003
	Left Extensor	59.74	12.61	37.06	10.60	0.000	72.51	26.52	56.59	14.72	0.004
	Left Palmar	45.40	13.04	27.98	23.12	0.011	64.02	23.96	55.18	18.30	0.046
	Left Dorsum Manus	61.88	9.97	39.11	17.13	0.000	69.35	33.69	50.88	17.42	0.007
pH	Left Flexor	5.19	0.16	5.40	0.33	0.016	5.32	0.22	5.48	0.22	0.029
	Left Extensor	5.22	0.14	5.43	0.30	0.005	5.31	0.24	5.52	0.26	0.022
	Left Palmar	5.36	0.27	5.83	0.29	0.000	5.52	0.33	5.74	0.29	0.006
	Left Dorsum Manus	5.15	0.21	5.51	0.28	0.000	5.38	0.23	5.60	0.27	0.009

On the fifth week after washed out, the test gloves were used on the left hand and the personal gloves were used on the right hands. TEWL level results on right and left hands flexor were 35.99 g/m<sup>2</sup>/h and 26.80 g/m<sup>2</sup>/h; extensor 28.00 g/m<sup>2</sup>/h and 27.31 g/m<sup>2</sup>/h; palmar 52.29 g/m<sup>2</sup>/h and 53.18 g/m<sup>2</sup>/h; and dorsum 35.91 g/m<sup>2</sup>/h and 38.16 g/m<sup>2</sup>/h. Skin hydration level results on right and left hands flexor were 77.00 AU and 70.66 AU; extensor 73.30 AU and 72.51 AU; palmar 55.62 AU and 64.02 AU; and dorsum 72.43 AU and 69.35 AU. Furthermore,

pH results on right and left hands flexor were 5.43 and 5.32; extensor 5.32 and 5.31; palmar 5.54 and 5.52; and dorsum 5.32 and 5.38 (Table 1, Table 2).

On the last week of measurements, TEWL level results on right and left hand's flexor were 27.92 g/m<sup>2</sup>/h and 27.53 g/m<sup>2</sup>/h; extensor 23.12 g/m<sup>2</sup>/h and 22.06 g/m<sup>2</sup>/h; palmar 56.48 g/m<sup>2</sup>/h and 56.67 g/m<sup>2</sup>/h; and dorsum 30.84 g/m<sup>2</sup>/h and 33.30 g/m<sup>2</sup>/h. Skin hydration level results on right and left hand's flexor were 57.95

AU and 56.66 AU; extensor 55.64 AU and 56.59 AU; palmar 54.76 AU and 55.18 AU; and dorsum 50.50 AU and 50.88 AU. The skin pH results on right and left hand flexor 5.57 and 5.48; extensor 5.46 and 5.52; palmar 5.56 and 5.74; dorsum manus 5.63 and 5.60 (Table 1, Table 2).

In this study, the results at fifth and sixth on the TEWL level measurement were not significantly

different except for the left dorsum (p=0.040; CI 95%). Meanwhile there were significant differences of skin hydration level results in all area (p<0.05) except the right palmar (p=0.795; CI 95%). There were significant differences of skin pH on the right dorsum manus (p=0.000; CI 95%), left flexor (p=0.029; CI 95%), left extensor (p=0.022; CI 95%), left palmar (p=0.006), and left dorsum manus (p=0.009; CI 95%).

**Table 3. Comparison of using gloves in the right hand and left hand at first week and second week.**

		First week					Second week				
		Right hand		Left hand		p	Right hand		Left hand		p
		Mean	±SD	Mean	±SD		Mean	±SD	Mean	±SD	
TEWL level (g/m <sup>2</sup> /h)	Flexor	27.98	9.10	29.64	14.36	0.925	27.24	14.94	24.66	13.65	0.474
	Extensor	26.07	9.82	27.09	11.92	0.794	18.72	8.43	19.77	12.04	0.777
	Palmar	48.56	11.33	47.05	12.11	0.718	50.98	9.67	54.49	9.20	0.301
	Dorsum manus	40.77	10.25	33.16	12.52	0.070	20.54	8.54	23.61	9.23	0.336
Skin hydration level (AU)	Flexor	58.77	14.46	61.61	19.25	0.640	44.13	15.60	38.74	11.03	0.418
	Extensor	63.80	16.28	59.74	12.16	0.436	35.38	13.86	37.06	10.60	0.703
	Palmar	46.53	15.34	45.40	13.04	0.812	29.47	11.58	27.98	23.12	0.214
	Dorsum Manus	63.93	15.09	61.88	9,96	0.653	36.67	12.84	39.11	17.13	0.626
pH	Flexor	5.18	0.15	5.19	0.16	0.974	5.37	0.42	5.40	0.33	0.774
	Extensor	5.22	0.13	5.25	0.18	0.911	5.49	0.30	5.43	0.30	0.696
	Palmar	5.25	0.18	5.36	0.27	0.215	5.81	0.24	5.83	0.29	0.831
	Dorsum Manus	5.03	0.28	5.15	0.20	0.059	5.51	0.30	5.51	0.28	0.928

**Table 4. Comparison of using gloves in the right hand and left hand at fifth week and sixth week.**

		Fifth week					Sixth week				
		Right hand		Left hand		P	Right hand		Left hand		P
		Mean	±SD	Mean	±SD		Mean	±SD	Mean	±SD	
TEWL level (g/m <sup>2</sup> /h)	Flexor	35.99	29.38	26.80	15.58	0.228	27.92	8.88	27.53	12.21	0.919
	Extensor	28.00	13.61	27.31	11.89	0.821	23.12	8.26	22.06	6.47	0.689
	Palmar	52.29	11.16	53.18	11.16	0.819	56.48	9.12	56.67	12.19	0.959
	Dorsum manus	35.91	11.08	38.16	12.89	0.601	30.84	10.17	33.30	10.58	0.508
Skin hydration level (AU)	Flexor	77.00	23.67	70.66	21.11	0.430	57.95	12.10	56.66	13.65	0.760
	Extensor	73.30	23.54	72.51	26.52	0.880	55.64	12.30	56.59	14.72	0.844
	Palmar	55.62	22.88	64.02	23.96	0.319	54.76	15.92	55.18	18.30	0.880
	Dorsum Manus	72.43	31.51	69.35	33.69	0.734	50.50	16.24	50.88	17.42	0.950
pH	Flexor	5.43	0.17	5.32	0.22	0.117	5.57	0.25	5.48	0.22	0.303
	Extensor	5.32	0.22	5.31	0.24	0.914	5.46	0.27	5.52	0.26	0.503
	Palmar	5.54	0.27	5.52	0.33	0.664	5.56	0.26	5.74	0.29	0.082
	Dorsum Manus	5.32	0.27	5.38	0.23	0.500	5.63	0.28	5.60	0.27	0.763

## Discussion

Batik workers are directly and indirectly exposed to irritant materials of dyes. Batik candles consist of coconut oil, bee hive, animal fat, paraffin. This ingredient may increase the risk of skin dryness and irritant contact dermatitis. Clinical manifestations of contact dermatitis are pruritus, roughness, tightness, burning sensation and pain, followed by lack of elasticity, texture coarsening, and skin wrinkle.<sup>8,9</sup> Occupational contact dermatitis is the most common occupational diseases. That can be prevented by elimination, substitution, engineering controls, and personal protective equipment (PPE).

Using gloves is one of prevention modality, that may reduce the risk of chemical exposure.<sup>6,10</sup>

In second week after using test gloves in right hand there were significant difference in TEWL level, skin hydration level, and pH results except TEWL level on flexor, TEWL level on palmar and pH on flexor. Not only in the right hand in first week, but also left hand using personal gloves showed significant difference on TEWL level, skin hydration level, and pH results, except TEWL level on flexor and palmar. This suggests that the use of gloves on batik workers can improve the skin barrier function. Some literature showed clinical

improvement of contact dermatitis after using PPE.<sup>11</sup> PPE can vary in form such as gloves, aprons, overalls, hats, safety boots and masks.<sup>12</sup> There are many types of gloves such as type I (disposable gloves), type II (household gloves), type III (industrial gloves), and type IV (special gloves). There are also various kinds of gloves materials, made from rubber, plastic, textile, or combination. Some literatures said that protective gloves may give protection for working, involving direct contact with solvent for several hours.<sup>13</sup>

Protective gloves must be periodically checked and inspected if any holes are found, that condition can absorb the allergens or irritants. Effectively prevention of contact dermatitis may use disposable gloves and frequent changes; but as long as the gloves are intact, frequent changes are not necessary to prevent contact dermatitis. Any substances in the gloves that should be used for dry work are fabric gloves (e.g., cotton or leather), and for wet work should be cotton gloves which absorb sweat.<sup>14</sup> Furthermore, gloves that can protect from solvents and inks are nitrile and neoprene gloves.<sup>14</sup>

However, the use of waterproof gloves over period time must be considered hazardous to the skin, due to occlusive effect in moist chamber.<sup>10</sup> Some literatures reported although the gloves can protect from irritant, allergen and microbial agents, gloves can be a etiologic factor in occupational contact dermatitis if not used properly.<sup>12</sup> Kwon et al, reported a case of irritant contact dermatitis caused by chronic cutaneous exposure to solvents on the inner surface of gloves.<sup>15</sup>

Some mechanisms by which gloves can be exposed to chemicals are contamination, permeation, and penetration. When workers open the gloves incorrectly without first cleansing of the hand and the contamination of gloves interiors are very common problems. The physical defect of gloves can be a process of solvent penetration, like a hole in the gloves.<sup>14</sup> One study shows evidence that the use of cotton gloves liners can prevent form contact dermatitis rather than wearing occlusive gloves.<sup>16</sup> In other studies reported that appropriate

PPE use is highly recommended due to batik workers might be exposed any substances and materials.<sup>17</sup> There are many factors can be a protective gloves include gloves material, the additive used in manufacturing, the manufacturing process, and the thickness and homogeneity of the material.<sup>14</sup> Choosing suitable gloves for chemicals or solvent is very important, that there are some chemicals for which no gloves can provide protection for long periods time.<sup>18</sup>

This study showed that any types of gloves may give protection for batik workers in batik production, since there were no significant difference between the skin barrier function after wearing test gloves and personal gloves. However, the length of the gloves may also play role in the protection itself. Short gloves may increase the risk of allergens or irritant contamination inside the gloves.

## Conclusion

Personal gloves and test gloves usage for protection doesn't have much significant difference. Glove usage can reduce TEWL that can give a protective effect, however, there is a risk of contact dermatitis because it can increase pH and reduce skin hydration. Wearing gloves may also give risk to trigger contact dermatitis if not used properly or using incompatible material.

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