An investigation into the physical and functional properties and sew ability of Faux leather

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Abstract:
Synthetic leather via natural is one of the most common synthetic leather with higher quality. Real leather goods are preferred by many customers because of their excellent properties, such as good water vapor permeability, and wearing comfort. Therefore, the development of synthetic leather via natural with excellent performance as a supplement of real leather has gained increasing attention and has become a widely interesting research topic. Synthetic leather via natural can be described as faux leather which has been emerged in recent years and became the most ideal substitute for real leather. Continuous development in this research area led to an expansion of faux leather applications.

In this study three different types of synthetic leather via natural were examined before and after sewing with superimposed seam. Tests were applied to determine the physical properties like thickness and stiffness, the functional properties like tensile strength, elongation, crease recovery, air permeability, vapor permeability, abrasion resistance, and colorfastness to light in addition to the seam properties like seam thickness, seam stiffness, seam tensile strength, seam pucker and seam appearance. All tests were done according to standards and took place into conditioned atmosphere of 21ºC and 65% RH. Comparisons have been made among them; this was done with reference to durability, efficiency and appearance.

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Introduction
It is no doubt that synthetic leather via natural is animal friendly fabric. It consists of split leather combined with a layer of polyurethane PU which is embossed onto the surface. It also referred to faux leather which has some similarities to real leather. Real leather is durable, of superior quality and will mostly last a very long time. Faux leather on the other hand is manmade and looks and feels a lot like real leather. Whereas it is less durable than real leather, it is considerably cheaper and is used to produce great looking and affordable products. (1) Although properties such as the aesthetical behavior of this faux leather and those of real leather are similar, a relatively deep gap exists between them in the terms of several other properties, especially water vapor permeability. The main reason for the difference between the hygienic property of synthetic leather and real leather is that more hydrophilic groups exists in the collagen fibers of real leather than those in synthetic leather.

Several exploratory studies regarding the modification of synthetic leather have been carried out to solve this problem. By integrating numerous published reports, it was found that increasing the internal active groups of synthetic leather is the most effective modification method. This method can be divided into two directions according to the two components of synthetic leather. In other words, modified polyamide fiber and modified polyurethane. (2)

1.1. Comparison between synthetic leather via natural and real leather
There is a difference between real leather and synthetic leather via natural. The main differences between real and faux leather are the quality and durability. Spotting the difference between faux and real protected leather can be difficult because they can look very similar. There are several techniques that are used to identify faux leather. In the past, faux leather is considered as fake substitute with very low value. Only real leather can be seen as high-end luxury products. High-end fashion brands would never use the synthetic one. However, due to the advance development of the synthetic leather in the past few years, the quality and functions of faux leather have been greatly improved. It is increasingly popular in the apparel industry due to its highly leather-like appearance

Keywords:
- synthetic leather
- via natural,
- faux leather,
- real leather,
- sew ability
and texture. It is now made to be a wide range of apparel product and people are more willing to wear them. In the future, adding value to this leather will be a significant study in the apparel industry. In order to evaluate the possibility of replacing real leather by synthetic leather via natural, basic knowledge of synthetic leather via natural should be gained before going any further. Comparing the properties of both types of leather is useful to analyze the application and difference between real leather and synthetic leather via natural. Another main issue needed to be considered is the environmental as well as animal right aspects. Nowadays environmental impact is one of the biggest concerns in many industries, including the apparel industry. More and more designers tend to use the eco-friendly materials to show their environmental awareness. Especially by thinking deeper about where real leather comes from and how it is made, it would be no more natural. Therefore faux leather may be a better alternative.

1.2. Properties of synthetic leather via natural
- Synthetic leather via natural based products really looks great, last long and need little care. While real leather needs regular care and is quite expensive.
- Their products do not wear easily even though they do not last as long as real leather.
- They will however need regular care such as cleaning to remove dirt and dust and other contaminants.
- They also tend to stretch more than real leather.
- When their products get damaged, they can easily be repaired and more easily be replaced. While real leather is great costly and needs regular maintenance.
- Their products are more affordable, durable, and reliable and look greater than other synthetic products.

1.3. Production of synthetic leather via natural
Synthetic leather via natural is produced by coating polyurethane paste to textile materials. This faux leather is unthinkable without the textile substrate. In most cases it is knitted fabrics which transfer their properties to the final properties of it. Since they are materials mostly used as outerwear fabrics in apparel, their physiological properties are essential. Air, water and water vapor permeability, their strength and durability depend on the properties of individual properties of coated materials and final products. Since structured multilayered materials consist of different materials and various binders, besides material comfort it is important to pay great attention to their compatibility in different conditions. The target product to meet market requirements can be produced by appropriate selection of recipes for polymer coating, and by determination of construction parameters of the textile fabric as well as raw materials and production conditions. Comparing the properties of both types of leather is useful to analyze the application and difference between real leather and synthetic leather via natural. Another main issue needed to be considered is the environmental as well as animal right aspects. Nowadays environmental impact is one of the biggest concerns in many industries, including the apparel industry. More and more designers tend to use the eco-friendly materials to show their environmental awareness. Especially by thinking deeper about where real leather comes from and how it is made, it would be no more natural. Therefore faux leather may be a better alternative.

1.4. Uses of synthetic leather via natural in apparel
In recent years, synthetic leather via natural is increasingly popular. It has been used by many fashion designers to create apparel products such as jackets, jeans, skirts, tops and their complementary like handbags and shoes.

2. Experimental work

2.1. Synthetic leather via natural specifications
Three types of faux leather were examined with knitted fabric base of 100% polyamide 6.6: single jersey structure. Their appearance and texture was similar to types of natural leather. Faux leather1 (brown) is like lamb nappa for its soft and light-weight, (lamb nappa is taken out from a lamb or young sheep) faux leather2 (yellow) is like goat suede for its velvet-like surface (goat suede is generally the inner side of hide or skin next to
meat of animal, buffed to a smooth finish), while faux leather3 (off white) is like cow nappa for its smooth and soft surface (cow nappa is taken out from the outer skin of the cow). The following table1 illustrates the specifications of the tested faux leather.

- **Fig.1. Schematic of polyurethane coating for production of synthetic leather via natural**

<table>
<thead>
<tr>
<th>Faux leather type</th>
<th>Faux leather color</th>
<th>Stitch Wales/cm</th>
<th>Stitch courses/cm</th>
<th>Mass (gm/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faux leather1</td>
<td>Brown</td>
<td>15</td>
<td>18</td>
<td>290</td>
</tr>
<tr>
<td>Faux leather2</td>
<td>Yellow</td>
<td>20</td>
<td>22</td>
<td>306</td>
</tr>
<tr>
<td>Faux leather3</td>
<td>Off white</td>
<td>19</td>
<td>21</td>
<td>302</td>
</tr>
</tbody>
</table>

### 2.2. Sewing specifications

Each type of faux leather was sewed separately by using Japanese Mitsubishi sewing machine model LS2-1150 with speed 220 volt, 2850 cycles per min, and 5000 stitches per min and by using plastic presser. The following table2 illustrates the sewing specifications.

<table>
<thead>
<tr>
<th>Seam type</th>
<th>Thread type</th>
<th>Thread size</th>
<th>Needle size</th>
<th>Stitch type</th>
<th>Stitch density/cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superimposed</td>
<td>100% spun polyester</td>
<td>Ne 22/3</td>
<td>16</td>
<td>Lock stitch</td>
<td>3</td>
</tr>
</tbody>
</table>

### 2.3. Experimental tests

Tested samples examined before and after sewing. All tests were done by standard test methods in conditioned atmosphere of 20ºC ± 2 and 65% ± 2 RH. Tests included thickness test which was carried out by using Erazier Pregision Instrument, according to (B.S.-2544). Thickness before and after sewing was obtained from average of four readings. Stiffness test obtained before and after sewing. It was carried out by using Shirley stiffness tester according to (ASTM D 1388) (10). Tensile strength and extensibility was carried out by using Tensile tester according to (EN ISO 13934-1) (11); average of three readings has been obtained for each property. Abrasion resistance test was carried out by using Taber 515 abrasion tester, according to the (ASTM D3884) (12) for a number of cycles, 100 cycles, and mass loss were achieved before and after abrasion process. Abrasive paper was used as abrading instead of standard fabric, with 12KP load on top of abraded sample. Air permeability test was carried out by using Electronic air permeability tester (FX 3300), according to (ASTM D737). (13) Vapor permeability test was carried out by using the Dynamic moisture permeation cell, according to (ASTM F2298). This test indicates how much moisture can pass through a barrier in 24-hour period. (14) Colorfastness to light test was carried out by Colorfastness tester, according to the (AATCC 16). Samples were exposed to light for 72 hours and the evaluation were done by using the blue scale. (15) Seam strength obtained according to (BS51-31) (16). Crease recovery test based on Paramount crease recovery tester according to (BS 11313). (17) Angle of crease recovery, for both length and width directions have been viewed. Seam pucker has been evaluated, according to (AATCC 88B-1978) (18) and seam appearance; average of five readings has been obtained for each property.

### 3. Results and Discussion

#### 3.1. Physical properties of tested synthetic leather via natural

Table3 illustrates physical properties of tested
3.1.1. Thickness of tested synthetic leather via natural
All kind of leather suitable for apparel should to have thin thickness don’t exceed 1mm. As shown in table 3, fig. 2 it can be noticed that faux leather 2 gives the highest thickness then faux leather 3 while faux leather 1 gives the lowest value. This can be attributed to mass, (there is a direct relationship between mass and thickness).

3.1.2. Stiffness of tested synthetic leather via natural
Stiffness is defined as, the ability of a material to resist the deformation under stress. The greater the material stiffness, the less likely the material is to drape. Table 3, fig. 2 indicates that faux leather 2 gives the highest stiffness then faux leather 1 while faux leather 3 gives the lowest value, which can be attributed to elongation. Generally, materials with less elongation as real leather tend to be stiffer than those with more elongation as faux leather.

3.2. Functional properties of tested synthetic leather via natural

<table>
<thead>
<tr>
<th>Physical properties</th>
<th>Faux leather 1</th>
<th>Faux leather 2</th>
<th>Faux leather 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness (mm)</td>
<td>0.67</td>
<td>0.95</td>
<td>0.90</td>
</tr>
<tr>
<td>Stiffness (mg.cm)</td>
<td>193.28</td>
<td>235.62</td>
<td>162.4</td>
</tr>
</tbody>
</table>

Table 4: Functional properties of tested synthetic leather via natural

<table>
<thead>
<tr>
<th>Functional properties</th>
<th>Faux leather 1</th>
<th>Faux leather 2</th>
<th>Faux leather 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile strength (kgf)</td>
<td>57.2</td>
<td>62.2</td>
<td>46.55</td>
</tr>
<tr>
<td>Elongation (%)</td>
<td>43.49</td>
<td>41.15</td>
<td>56.3</td>
</tr>
<tr>
<td>Crease recovery / length (°)</td>
<td>128</td>
<td>118</td>
<td>134</td>
</tr>
<tr>
<td>Crease recovery / width (°)</td>
<td>118</td>
<td>110</td>
<td>125</td>
</tr>
<tr>
<td>Air permeability (cm²/cm²/sec.)</td>
<td>0.15</td>
<td>0.13</td>
<td>0.14</td>
</tr>
<tr>
<td>Vapor permeability (L/m²/sec.)</td>
<td>0.36</td>
<td>0.22</td>
<td>0.23</td>
</tr>
<tr>
<td>Abrasion (difference of lose in mass %)</td>
<td>8.3</td>
<td>9.2</td>
<td>6.6</td>
</tr>
<tr>
<td>Colorfastness to light (grade)</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>
3.2.1. Tensile strength of tested synthetic leather via natural

Tensile strength is the ability of a material to withstand a longitudinal pulling force. As shown in table 4, Fig. 3, faux leather 2 is more durable than faux leather 1 while faux leather 3 has the lowest value. (There is an inverse relation between tensile strength and elongation). However, faux leather is tenacious.

3.2.2. Elongation of tested synthetic leather via natural

Extensibility is the ability of a material to extend when subjected to mechanical forces. While all kinds of leather, however real or faux, stretch more in width direction than in length, faux leather tends to stretch more than real leather. It can be noticed from Table 4, Fig. 3 that faux leather 3 elongates more than faux leather 1 while faux leather 2 has the lowest elongation. (There is an inverse relation between elongation and stiffness). Extensibility is an important consideration in the shape retention of apparel. Materials with low elongation tend to be stiffer than those with more elongation and keep their original dimensions during use.

3.2.3. Crease recovery of tested synthetic leather via natural

The bending elasticity is the greatest importance in the phenomenon of creasing. Creases appear when the material is distorted in such a manner the ability of a material to regain its original shape after it has been wrinkled. As shown in Table 4, Fig. 3, crease recovery in length direction is higher than in width direction. Faux leather 3 has the highest crease recovery than faux leather 1 while faux leather 2 has the lowest value, which can be attributed to their stiffness (as stiffness increases crease recovery decreases). Crease recovery effects on the aesthetic appeal of apparel. (As crease recovery increases a better aesthetic appeal is given).

3.2.4. Air permeability of tested synthetic leather via natural

Air permeability is the case with which air passes through material. It determines factors such as
wind resistance and breathability. To avoid the condensation of perspiration in a garment, breathable materials are required. It also influences the warmth or coolness of a garment. Table4, fig.3 shows that faux leather1 is more air permeable than faux leather3 while faux leather2 has the lowest value which can be attributed to their thickness (as thickness increases air permeability decreases and vice versa). Of course real leather is more breathable than faux leather whereas faux leather breathes more than other windproof synthetic products.

3.2.5. Vapor permeability of tested synthetic leather via natural
Vapor permeability which also referred to breathability, describes a material’s ability to allow water in its gases form to pass through it. Table4, fig.3 shows that faux leather1 is more vapor permeable than faux leather3 while faux leather2 has the lowest value which can be attributed to the thickness (as thickness increases vapor permeability decreases and vice versa) like air permeability. In general vapor permeability of synthetic leather via natural is the most optima property among all the other synthetic leathers.

3.2.6. Abrasion resistance of tested synthetic leather via natural
Abrasion resistance is the ability of a material to withstand rubbing (frictional force) applied to its surface (as smooth surface has higher abrasion resistance than rough one). Table4, fig.3 shows that faux leather2 has the highest difference of lose in mass due to its smooth and soft surface which is high abrasion resistance. There is no doubt that real leather resist abrasion more than faux leather which consists of two components (polyamide fiber and polyurethane).

3.2.7. Colorfastness to light of tested synthetic leather via natural
Colorfastness to light means resistance of the materials color to fade or run when they are exposed to light for 72 hours. To measure the colorfastness to light a blue scale is used, it is categorized from one to eight.

Table5 Colorfastness to light grades

<table>
<thead>
<tr>
<th>Grade</th>
<th>Degree of Fading</th>
<th>Light Fastness Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>No fading</td>
<td>Outstanding</td>
</tr>
<tr>
<td>7</td>
<td>Very slight fading</td>
<td>Excellent</td>
</tr>
<tr>
<td>6</td>
<td>Slight fading</td>
<td>Very good</td>
</tr>
<tr>
<td>5</td>
<td>Moderate fading</td>
<td>Good</td>
</tr>
<tr>
<td>4</td>
<td>Appreciable fading</td>
<td>Moderate</td>
</tr>
<tr>
<td>3</td>
<td>Significant fading</td>
<td>Fair</td>
</tr>
<tr>
<td>2</td>
<td>Extensive fading</td>
<td>Poor</td>
</tr>
<tr>
<td>1</td>
<td>Very extensive fading</td>
<td>Very poor</td>
</tr>
</tbody>
</table>

Table5 shows the colorfastness to light grades. As shown in table4, fig.3 all tested samples evaluated outstanding colorfastness to light. Generally synthetic leather has better colorfastness than real leather, because it’s produced by coating colored polyurethane paste to textile materials, while real leather is colored during finishing after tanning. Therefore real leather is prone to fade when exposing to the sun for an extended period of time.

Table 6 Seam properties of tested synthetic leather via natural

<table>
<thead>
<tr>
<th>Seam properties</th>
<th>Faux leather1</th>
<th>Faux leather2</th>
<th>Faux leather3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seam thickness (mm)</td>
<td>1.29</td>
<td>1.85</td>
<td>1.74</td>
</tr>
<tr>
<td>Seam stiffness (mg.cm)</td>
<td>395.62</td>
<td>443.7</td>
<td>365.4</td>
</tr>
<tr>
<td>Seam tensile strength (N/mm)</td>
<td>5.99</td>
<td>6.88</td>
<td>4.94</td>
</tr>
<tr>
<td>Seam pucker (level)</td>
<td>4.8</td>
<td>3.8</td>
<td>4.4</td>
</tr>
<tr>
<td>Seam appearance (level)</td>
<td>9.6</td>
<td>7.2</td>
<td>8.8</td>
</tr>
</tbody>
</table>

Fig.4 (a)  Fig.4 (b)
3.3.1. Seam thickness of tested synthetic leather via natural
As shown in table 6, fig.4 faux leather2 gives the highest seam thickness then faux leather3 while faux leather1 gives the lowest value.

3.3.2. Seam stiffness of tested synthetic leather via natural
Seam stiffness of tested faux leathers goes in the same manner like their tensile strength. As shown in table 6, fig.4 faux leather2 is more durable than faux leather1 while faux leather3 has the lowest value.

3.3.3. Seam tensile strength of tested synthetic leather via natural
Seam tensile strength of tested faux leathers goes in the same manner like their tensile strength. As shown in table 6, fig.4 faux leather2 is more durable than faux leather1 while faux leather3 has the lowest value.

3.3.4. Seam pucker of tested synthetic leather via natural
Seam pucker is a wrinkled appearance along the seam, which influences the appearance to a considerable degree. This procedure is objective and is focused on the aesthetic property of the seam assembly. Seam pucker evaluated (from 1 to 5) where 5 means no pucker and 1 means severely pucker. As shown in table 6, fig.4 faux leather1 gives the lowest seam pucker (highest level) then faux leather3 while faux leather2 gives the highest value (lowest level).

3.3.5. Seam appearance of tested synthetic leather via natural
The visual appeal of the garment is a principal factor deciding its value. Appearance evaluated (from 2 to 10) where 10 means best appearance and 2 means worst appearance. As shown in table 6, fig.4 faux leather1 gives the highest seam appearance then faux leather3 while faux leather2 gives the lowest value (As the seam pucker decreases, seam appearance increases).

Conclusions
- Synthetic leather via natural has a significant effect on each of physical, functional and seam properties.
- There is a direct relationship between faux leathers mass and its thickness.
- There is an inverse relation between faux leathers elongation and each of stiffness and tensile strength.
- There is an inverse relation between faux leathers stiffness and crease recovery.
- There is an inverse relation between faux leathers thickness and each of air and vapor permeability.
- Seam properties of each thickness, stiffness and tensile strength of tested faux leathers go in the same manner like before sewing.
- There is an inverse relation between faux leathers seam pucker and its seam appearance.
- Faux leather1 (brown) is like lamb nappa for its soft and light-weight. It’s distinguished than the other tested leathers for its smallest mass,
thickness and seam thickness, highest air and vapor permeability, in addition to its lowest seam pucker and its greatest seam appearance. Therefore authors recommend using it for making sportswear jackets.

- Faux leather3 (off white) is like **cow nappa** for its smooth and soft surface. When comparing it with the other tested leathers, results referred that it has the advantage of smallest stiffness and seam stiffness, highest elongation, crease recovery and abrasion resistance making it suitable for a host of fashion apparels.

- Faux velvet2 (yellow) is like goat suede for its velvet-like surface. It’s characterized only by tensile strength and seam tensile strength than the other tested leathers. Therefore the authors recommend using this type in apparel parts which are more subjected to high tensile strength.

- There is no doubt that real leather exceeds synthetic leather via natural by durability, abrasion resistance, breathability and vapor permeability but in general these properties are greater in synthetic leather via natural among all the other synthetic leathers.

- Synthetic leather via natural exceeds real leather by elongation, drape ability, crease recovery and color fastness which effects on its aesthetic appeal. In addition it is considerably cheaper.

- In the fashion world, authors’ advice designers to use synthetic leather via natural since it can add value to their products, and customers to purchase it due to its high-end image and performance.

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14- ASTM F2298: Method for determination of vapor permeability.

15- AATCC 16: Method for determination of colorfastness to light.

16- BS51-31: Method for determination of seam strength.

17- BS 11313: Method for determination of crease recovery.