Polyester Microfibres for Production of a Comfortable and Affordable Sanitary Pad

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Abstract: The widespread ignorance on how menstrual hygiene negatively impacts on the well-being of girls and women, and contributes to their marginalisation in some societies is a cause for concern in many poor countries. These poor countries are characterized by poor sanitary facilities, among other issues. These, together with lack of sanitary supplies can impact negatively on girls especially when at school, affecting their performance. Sanitary pads prove expensive for the poor. An average pack of 8-10 pads costs $US1.50 and a woman needs two to three packets in one menstrual cycle. This has caused women to resort to unhealthy ways of menstrual management. For instance they use crude materials such as grass and cow dung, which could bruise them and expose them to infections. The aim of the study was to use polyester microfibres for development of a re-usable sanitary pad because polyester has desired properties such as high absorbency, comfort when worn, pose no health risk and are affordable. A polyester pad was produced and synthetic blood used to test for its absorbency and wicking ability, comparing it to the commercial disposable pads. The new pad exhibited improved properties and was ten times less in cost than the cheapest commercial pad hence suitable for the poor communities.

Keywords: sanitary pad, polyester microfibre, menstrual hygiene, absorbency, wicking

1. INTRODUCTION

The natural process of menstruation comes as a big problem for women and girls in Zimbabwe since commercially produced disposable sanitary pads are too expensive. These sanitary napkins or pads classified as absorbent articles are designed to be worn by females to absorb menstrual fluids and other excrements discharged by the body during a menstrual period. A lot of these absorbent articles (both disposable and re-usable) such as diapers, napkins and sanitary pads, can be used for menstrual collection (Serbiak et al., 1993). In Zimbabwe, an average pack of ten disposable sanitary pads costs about $US1.50, which is significantly expensive for poor females, taking into account that the female will need two to three packets per month. A re-usable sanitary pad would be cost effective for the poor as there would not be any need to purchase pads every moth. The pad should have ease of maintenance, thus should wash clean easily leaving no stain. Commercially developed re-usable sanitary pads are not readily available. The cost attached to these disposable sanitary pads makes them too expensive for most rural women. This has led them to resorting to crude means of collecting menstrual blood, which include using pieces of rags, newspapers, cow dung and tissues as sanitary ware.

When re-usable pieces of cloth (which are usually cotton) are used, they tend to remain with permanent stains after wash. This could be a suitable breeding environment for microbes that can be hazardous to health. In most cases the methods used for collecting menstrual blood are very unhygienic and expose women to vaginal infections which can affect their reproductive health (House et al., 2012). The water, sanitation and hygiene (WASH) programmes in Zimbabwe advocate for improved sanitary facilities and resources. Poor sanitary facilities, inadequate provision of sanitary supplies and educational facilities can impact negatively on girls in terms of school access, performance and success.

2. AVAILABILITY OF SANITARY PADS

2.1. Disposable pad

The commercially available sanitary pads are made from conventional fibres cotton and paper. These take into account the weight of the menstrual flow that differs from woman to woman (Jacek, 2002). As much as cotton is used in the making of disposable sanitary pads, it is common knowledge that modern disposable and re-usable articles for personal and health care should offer excellent absorbency and comfort. Materials used for the absorption of menstrual blood should combine all the necessary functions such as; fluid acquisition, distribution and retention (Jacek, 2002).

Available sanitary pads are manufactured locally (e.g. Farai) and also imported (e.g. Johnson and Johnson, Always, Kotex just to mention a few). The difference between these sanitary pads implies that the method of manufacture is different as noted by their different level of performance. The common types of pads include:

The Cotton type: with an absorbent polymers, wings, special dry soft covers that enhance softness and freshness. The absorbent polymer keeps the surface dry so as to avoid leakages and,

The Soft and dry type: with a soft and comfortable surface, made from absorbent polymer and natural wood pulp that absorb moisture quickly and are soft. These however expire after three years on the shelve (Rodrigues et al., 2012).

Disposable sanitary pads made from cellulosic material such as wood pulp fluff have relatively good absorbency and some shape recovery when dry but unfortunately not when wet. The cellulosic material collapses when wet resulting in loss of shape, thus leading discomfort (Rodrigues et al., 2012). Besides, disposable sanitary pads also pose environmental concerns as some of the materials used in the pads are non- biodegradable. Disposal through incineration contributes to pollution, while burying the used pads in the ground is not environmentally friendly either as some of the materials in the pad are non-biodegrade and will remain in the environment unchanged for hundreds of years (Carr et al., 2009). The main components of a disposable pad are as in Fig 1.

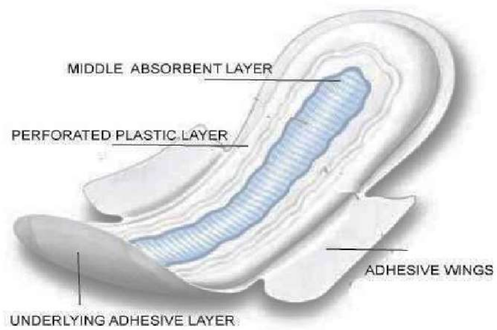

Figure 1 The main components of a disposable sanitary padn (Pinho, et al., 2010).

2.2. Re-usable pad

Re-usable sanitary pads are made of different materials such as cotton, silk, bamboo and hemp that offer a good absorbency (Pinho et al., 2010). Most designs are similar to those of disposable pads, with a bottom layer, a top layer and an absorbent core. New designs may be made with wings that secure around the underpants or without, and just held in place between the body and the underpants with the help of only an underlying adhesive on its bottom layer, whilst the older styles are available in belted styles.

Washable menstrual pads do not need to be disposed of after use and therefore offer a more economical alternative for women. They have become a popular alternative and gaining popularity among women, because they are perfume free, and can be more comfortable for women who suffer from irritations as a result of using disposable pads (Mazgaj et al., 2006). Different types of microfibers such as polyacrylonitrile, polypropylene, cellulose, acetate, and rayon can be used for the production of the re-usable sanitary pads. However, these differ in absorption, wicking and comfort properties. Mixtures of polymers such as polyester-nylon and polyester-polypropylene are also used. Polyester microfiber materials were used due to their ease of availability in Zimbabwe.

The aim of the study was to use polyester microfibres to develop an affordable and re-usable sanitary pad with good performance properties. In order to fulfil the aim of the project the objectives of were set as follows;

i. Design an affordable but reliable sanitary pad from polyester microfibre that provides easy management of menstrual hygiene
ii. Determine functional properties of the polyester pad and compare to those for the pads on the market.

3. METHODOLOGY

3.1. Designing a polyester sanitary pad

The pad was designed using measurements of the Johnson and Johnson re-usable pad design. Polyester microfibre materials were used for pad sample (Kimiran et al., 2008). The polyester microfibre sanitary pad was developed as follows [Fig 3]:

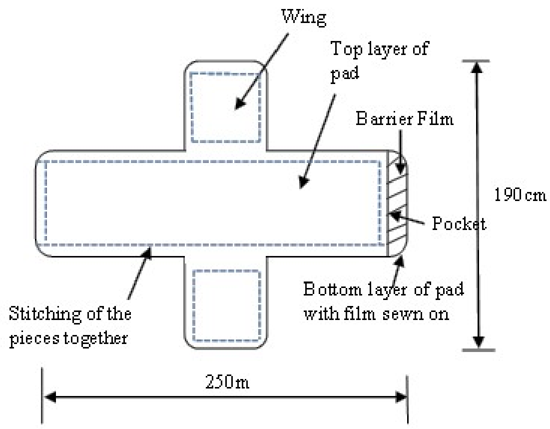

Figure 2 Measurements of the newly designed polyester microfibre pad (Christopher et al., 2014)

The bottom cover and top cover of 250 mm x 60 mm, with wings (65 mm x 40 mm) on each side, were cut to shape from a woven polyester microfibre materials plain and pile respectively (Christopher et al., 2014). The polyester microfibre material was chosen because it is comfortable to wear close to the skin. The woven structure makes it, strong and yet porous thus enhancing breathability of the sanitary pad (Christopher et al., 2014; Sandip et al., 2007). The same measurement was used to cut a piece of polyethylene film to create water proof layer of the pad (cut without wings). The film material was attached to the bottom layer. The polyethylene material is cheap, less bulky, flexible, light and strong enough to withstand forces experienced during normal usage (Mazgaj et al., 2006; Christopher et al., 2014). The pile loops on the top cover will increase the absorption capacity of the fluid and transport it into the inner absorbent core. The top layer is sewn onto the previous two, with the polyethylene film in between, forming a pocket between the top layer and the polyethylene film. The pocket created is where the insert material that absorbs the fluid will be placed.

An insert was cut out from a compactly woven polyester microfibre cloth. The compactness of the weave coupled with the nature of the fibre should allow gradual flow and uniform distribution of the fluid (Kimiran et al., 2008) Non-compact structures infringe on fluid retention. An adhesive material was then sewn onto the wing and the same adhesive material used to fasten the pad to the underwear (Fig 3).

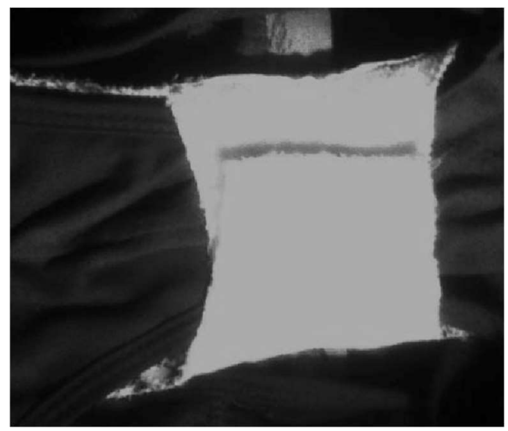

Figure 3 Fastening of pad onto the under wear

3.2. Functional properties of the sanitary pad

The absorbency, leakage, wicking and strike through experiments were conducted on five different thicknesses (ultra-thin which is 2 mm thick; light which is 4 mm thick; regular which is 6 mm thick; medium which is 8 mm thick; and supper which is 10 mm thick) of three different types of sanitary pads which were: imported commercial sanitary pad; locally manufactured commercial sanitary pad; and the newly designed polyester sanitary pad in order to compare their functional properties. This resulted in 15 tests being conducted per experiment.

Synthetic blood used for experiments was made using the following ingredients (Joanne, 2004):

1. Plain flour 10g
2. Distilled water 200ml
3. Scarlet food colouring 2ml

This homogeneous constituency imitates real blood (Christopher et al., 2014, Joanne, 2004).

3.3. Absorbency experiments

Absorbency experiments were conducted according to EAS 96:2008-Annex C, as laid out in the Ugandan Standard Tests for Sanitary Towels Document. A balance was used to determine the amount of uptake of fluid by the pad. Its weight was measured before and after saturating it with the synthetic blood (Joanne, 2004). On reaching saturation point the pad had a 1 kg weight placed on it so as to remove the excess fluid within it. More liquid was blotted from the pad using filter paper and the pad weighed. The purpose of the load was to simulate the weight of the woman as she sits on the pad during menstruation. The load also helps to measure the extent to which the protective barrier prevents leakage in the pad (EAC, 2008).

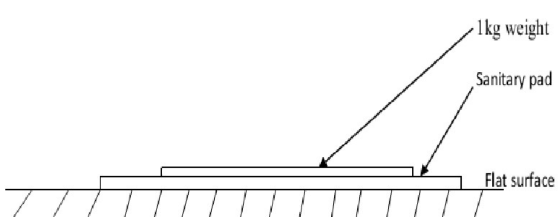

Figure 4 Pad subjected to pressure through of a 1kg weight (Christopher et al., 2014).

Fluid absorbency was calculated using the following formula;

Change in mass in grams (Z)= (X-W)g

Where

W is the initial dry weight of the pad expressed in grams.

X is the final weight of the pad expressed in grams, after absorption of the test liquid.

Z is the change in mass of the pad after absorption of test liquid.

3.4. Leakage experiments

To test the efficiency of the protective barrier used in newly designed sanitary pad, leakage experiments were conducted using the Cone Method Test according to EAS 96:2008-Annex B as laid out in the Ugandan Standards Tests for Sanitary Towels Document (EAC, 2008). Pieces of the protective barrier (polyethylene material) were cut into a square of approximately 6.5 cm per side, and folded into a cone without creasing; These were placed in a filter funnel which was mounted over an empty beaker (Fig 5).

Figure 5 Set up for leakage experiment to assess the effectiveness of the polyethylene barrier material

The funnel was then filled with the test liquid and left to stand for 48 hours after which it was check if any liquid had passed through (EAC, 2008).

3.5. Wicking experiments

The polyester microfibre pad was tested for its wicking property and compared with the available commercial pads. Test were conducted according to BS3424 Method 21(1973) 'Determination resistance to wicking' (EAC, 2008) which is a vertical strip experiment meant to test the ability of the material to take up fluid. The pads were dipped 10 mm in the blood substitute and fluid absorption along the pad was measured in millimetres after 30 minutes (EAC, 2008).

3.6. Strike through experiments

Strike through was determined by dropping the test liquid on the pad sample. A small volume (2.0 ml) of blood substitute test liquid was used and its penetration though the pad was measured (Justinger et al., 2009). Strike through was evaluated by measuring the time taken for the blood substitute to be absorbed from the upper layer of the pad to the inner layer. The drop was closely monitored until the bright red drop of the test liquid appeared like a dull spot on the pad sample, the pads being observed over the same period of time (Justinger, et al., 2009).

4. RESULTS AND DISCUSSION

Absorption capacity of the polyester microfibre pad The results from Fig 6 show sanitary pads absorption capacity (amount of liquid taken up) when subjected to 1 kg pressure. The polyester microfibre pad was compared to each of the five thickness of either the locally or the imported pad (which were classified according to their thicknesses from ultra-thin to the thickest super-size).

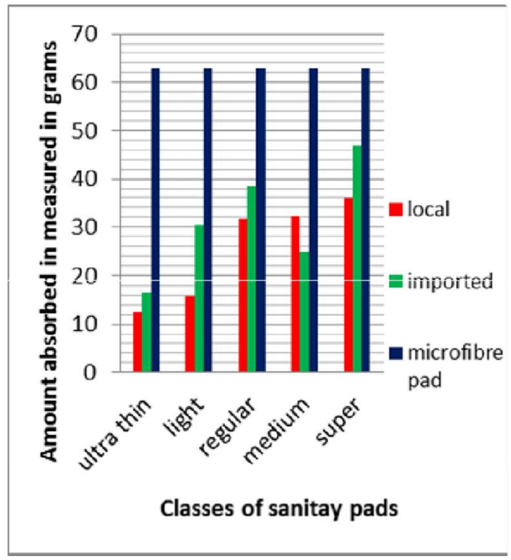

Figure 6 Absorption of test fluid by three different sanitary pads

The results indicate that the polyester microfibre pad had a higher absorption capacity than both (locally and imported) commercially available pads, and its absorbency was higher than that for all thickness. The new polyester microfibre pad could absorb 62 grams of fluid, while the imported pads absorbed more than the locally made (Fig 6). This is because the polyester microfibres have very high absorption capacity as compared to natural fibres that are found in some parts of commercial pads and also used in most re-usable pads. The commercial pads' absorption is a result of super-absorbent gels which form the core that is able to absorb and retain liquid under slight mechanical pressure (Christopher et al., 2014). These gels swell up holding the absorbed liquid in a solid, rubbery state and preventing any leakage, thus helping in making the pad remain feeling dry during usage. Results show that the absorption capacity of the commercial pads, both imported and locally made, is directly related to the thickness of the pads (Christopher et al., 2014).

The thinner the pad, the less absorbent it was and the imported pads performed better than the local brand. It was also observed that the imported pads possessed more gelatinous granules within their structures as compared to locally manufactured sanitary pads, which could have contributed to their better performance. In general the best wet comfort is provided by sanitary pads with higher absorption capacity, and low re-wet. The polyester microfibre pad with its desirable properties such as the high absorbency as compared to its commercial counterparts, also has an advantage of being re-usable. This makes the microfibre pad cheaper as each re-usable pad can be used for at least two years, because the polyester microfibres pads will be stronger and more durable than the cotton fibres pads that can be used for up to two years

4.1. Leakage

The polyethylene material sewn onto bottom layer was tested to determine its ability to prevent blood from passing through. Results showed that the polyethylene protective barrier was liquid proof. This is because polyethylene is an impervious continuous film, hence no liquid was collected in the beaker after 48 hours.

4.2. Wicking rate of the pads

Results (Fig 7) show that the polyester microfibre pad exhibited good wicking properties. The wicking tests also showed that both the local and imported pads exhibited comparable wicking rate. The polyester pad however, performed better than the best of the commercial pads, the ultra-thin. For the locally made pads wicking increases from a regular (6mm thick) to ultra-thin (2mm thick) and increases again from regular to medium (8 mm thick) and super(10mm thick). For the imported pad wicking increased as the pad got thinner. Varying wicking for these pads could be the result of the way the super absorbent gels are distributed within the pad. These super absorbent gels were responsible for the transportation of the fluid within the pad. Different types of gels absorb and distribute the fluids at different rates (Pinho et al., 2010, Christopher et al., 2014).

The high wicking values obtained in polyester microfibres are due to their super-absorbency, absorbing over 7 times their weight (Jacek, 2002; Christopher et al., 2014). The polyester also dries quickly, in one-third of the time of natural fibres (Jacek, 2002). Wicking in sanitary pads allows the blood to be distributed along the entire structure, and the pad to retain and distribute the collected blood in the pad, leading to reduction in leaking (Christopher et al., 2014).

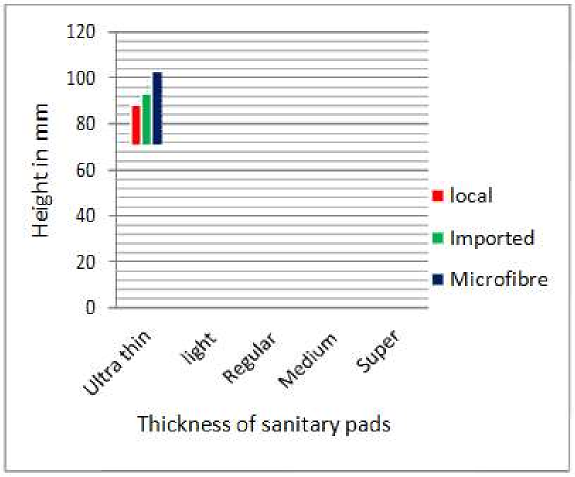

Figure 7 Vertical wicking for different sanitary pads

4.3. Liquid strike through of the sanitary pads

The strike through results shows the rate of fluid transportation from the top part of the pad to the inner collector layer of the pad.

Fig 8 shows that polyester microfibres have better strike through as compared to the local and imported commercial sanitary pads. The commercial locally made sanitary pads exhibited poor strike through properties as compared to imported pads, which also performed poorer than the re-usable designed polyester pad. In an ideal situation, the strike through results in this case indicates the rate at which the liquid was transported from the surface to the interior of the pad.

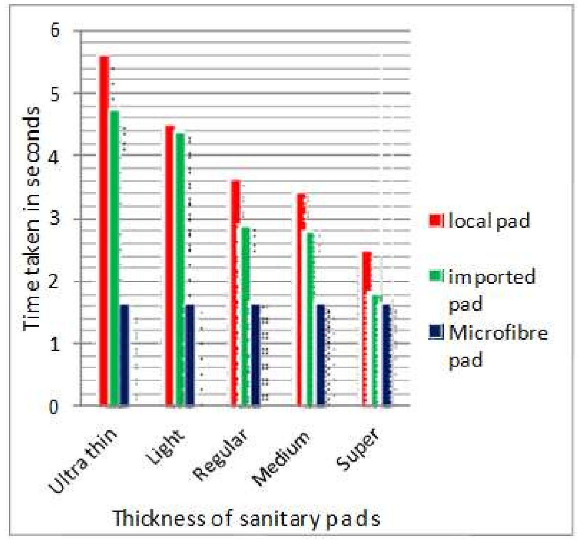

Figure 8 Liquid strike through for three different sanitary pads with varying thicknesses

Good resistance to strike through for polyester microfibres sanitary pad was a result of the high wicking behaviour of the polyester fibres. Wicking properties of the commercial pads increased with increase in thickness, from the ultra-thin type to super-size due to the increase in the quantity of the super absorbent granules that increased within the pad as the its thickness also increased (Christopher et al., 2014). When a pad has good strike through properties; it means that its upper surface readily takes up the blood and transports it to the next layer. The top layer should not cause discomfort to the wearer which means that it should have good wicking properties and yet not leak (Christopher et al., 2014).

4.4. Maintenance of the polyester microfibre pad

The newly designed sanitary pad is made from 100% polyester microfibre in all its components, top cover, bottom cover and insert. The insert is placed in the pocket between the covers. The pad is then fastened round the underwear using a sewn on adhesive material on the wings of the pad. The used insert material can be removed from the pad opening and together with the pad, socked in cold and mild salty water. Soaking in cold water minimizes the chances of staining so that the blood does not leave permanent stains. After soaking the pad is washed using detergent or soap to ensure that microbes are eliminated. Both the insert and outer shell are then dried in the sun, and sterilized using ultraviolet (UV) light and stored for future use.

Sun rays are natural sterilisers that kill germs and bacteria (Shanmugasundaram & Gowda, 2010). The polyester fibre, being synthetic will not attract microbes (Christopher et al., 2014).

4.5. Economics of using the polyester microfibre pad compared to the commercial brands

Table 1 Cost of producing one home-made polyester microfibre sanitary pad (Christopher et al., 2014)

Details	US$
Polyester microfiber material used on each pad (four pieces measuring 250X190mm at$2.00 (enough for one bottom cover, one top cover and at least two inserts)	2
Cost of washing soap ($0.20 worth of soap is required for 5 litres)	0.08
Polyethylene film-60mmX250mm (a1metreX1.5metre material cost $4.00)	0.06
Total cost of Velcro strips used-4cm (100cmofVelcroth at cost$1)	0.04
Total cost of materials and maintenance	1.18
Labour at 20% of total cost	0.24
Total cost of pad	2.40

4.6. Cost of production per sanitary pad

Production of one polyester microfibre sanitary pad is calculated taking into consideration cost of the materials used, and labour costs calculated as 20% percentage of total cost of materials (Table 1) (Christopher et al., 2014).

Re-usable baby diapers and sanitary pads made from a blend of bamboo and cotton fibres can last up to two years (Christopher et al., 2014; Huang et al., 2004; Martin et al., 2007). As cellulosic fibres they are prone to bacterial attacks, which means that the pads from polyester microfibres will last longer as polyester is resistant to bacterial attacks. Table 1 shows that the total cost of one re- usable polyester microfibre sanitary will be $2.40 and one would need at least three re- usable polyester sanitary pads per month will enable her to wear one pad while the second one is drying and the third on stand-by. This will cost the woman $7.20 for three pads that will last more than two years. Generally, for commercially available disposable pads, most women can spend $3.38(£2.25) to $7.5 (£5) per month on disposable sanitary pads (Christopher et al., 2014), which will amount to between $40.50 and $90.00 per year. The minimum amount spent in Zimbabwe will be $36.00 ($1.50 X 2 packets/month X 12) per year for locally manufactures and up to $86.40 to ($3.6 X2packets/month X12) for imported pads. The polyester microfbre sanitary pad is cheaper than the lowest priced disposable sanitary pads. The microfibre pad could be the most suitable as compared to available pads as it is not just cheaper than the disposable pads, but also washes easily and dries quickly as compared to re-usable pads made from cotton. The polyester microfibre is also comfortable close to the skin (Huang et al., 2004).

The re-usable microfibre sanitary pad also has an advantage of being highly absorbent with the capacity to quickly distribute the liquid within the pad coupled with minimum leakage (Martin et al., 2007). The microfibre pad offers the user a pad with performance properties similar to those found in the commercially available disposable brands, and yet affordable. The pad also offers easy maintenance and reduced straining, which are important in cultures where menstruation is associated with social stigma because women and girls can manage their menstruation without being noticed. The ease of washing also helps to eliminate the blood from the pad pieces. Blood remnants in pads can trigger the development of bacteria that may cause an odour in women with poor menstrual hygiene management. Besides the polyester microfibre pad will be more durable than the cotton pad because of its resistance to microbial attack. The developed pad is easy to wear as it sticks to underwear, thus reducing the risk of the pad falling during use.

The nature of materials used for making re-usable pads has an effect on the drying time and subsequently the cost of the product. In this case the cost covers the drying time, pad maintenance and the durability. The amount of time required for a pad to dry, combined with the frequency of replacing a soiled pad with a fresh pad, dictates the number of pads needed to get through an average menstrual cycle. The number of pads included in a package is directly proportional to the retail cost of the product. This is an important consideration, also given that the average consumer has very limited purchasing power. The faster the pads dry, the fewer pieces needed to be included in a package and therefore the cheaper the total cost of the package. Consequently, the re-usable pad is made from polyester rather than cotton due to the significant variance in drying time (Christopher et al., 2014, Shanmugasundaram & Gowda, 2010).

5. CONCLUSION

The re-usable polyester microfibre pad could be a solution to most poor women's need (especially those from rural areas where there are very few or even none, shops that sell pads). Menstrual hygiene management becomes a challenge. The designed polyester microfibre pads are easy to make as they can be produced in a rural or urban setting. A pack of three re-usable polyester microfibre pads will cost $7.20, and no other purchase could be made for the next two or more years. For women with heavy flows, a pack of five pads may be required and still this will cost them $12 in two or more years which is $24 cheaper than the lowest priced disposable pads required in a year. Given the fact that most of the cotton based re-usable sanitary pads have a lifespan of up to two years, the assumption is that the re-usable microfibre sanitary pad will last much longer due to the higher strength of the polyester microfibres, as well their non- susceptibility to microfibres (Christopher Chakwana, et al., 2014). Polyester microfibres possess more properties required in sanitary pads, such as absorbency, wicking and easy wash. The pad can be used over and over again, making it a cheaper option for poor women.

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