Development of Sanitary Towel Using Locally Available Natural Fibres for Marginalised Groups in Kenya

Githinji DN*, Githaiga JT, Odhiambo SA, Chemweno P

Department of Manufacturing, Industrial & Textile Engineering, Moi University, P.O. Box 3900, Eldoret, KENYA
davidnjugunaus@gmail.com

Abstract

Development of a reusable sanitary towel that is easy to make, affordable, and that utilises locally available natural fibres such as wool and cotton is described in this paper. A novel sanitary towel design consisting of a reusable outer shell and a disposable natural fibre insert is proposed and a prototype produced. The preparation of the natural fibres for sanitary towel use is described and their subsequent water imbibitions per gram of fibres established as 1.24 and 1.25 grams of water for cotton and wool fibres, respectively. The absorbency characteristics of the developed sanitary towel compare reasonably well to the KS 507:2005 Standards. The use, care and washing of the developed towel is describe and a cost analysis performed for different scenarios indicate a descent savings of up to 79% compared to commercial sanitary towel usage.

Key words: Sanitary towels, poverty, cotton, wool, absorbency and affordable.

1. INTRODUCTION

Sanitary towels are feminine hygiene products falling under the umbrella of personal care products**,** designed to absorb and contain body exudates. Menstruation comes as a big problem to women and girls in many parts of Africa with no access to sanitary towels contributing to social, cultural, and even health related problems. In Kenya, with an estimated population of 34 million and with more than 50% of Kenyans living below the poverty datum line i.e. their income is less than a dollar (equivalent to Ksh. 75) a day, affordability of a pack of sanitary towels retailing at a price ranging between Kshs.45.00 to Ksh. 90.00 is out of reach. Considering that women constitute the larger proportion of the population (approx.52%), it is clear that a big majority of women and girls cannot afford this basic commodity.

Lack of affordable sanitary protection in particular for girls attaining the age of puberty, lead to their disempowerment. They skip school during menstruation or drop out entirely because of lack of sanitation. Many girls from poor families cannot afford to buy sanitary pads and hence they resort to the use of unhygienic rags and cloths which puts them at the risk of infections. In addition, due to the use of improper methods to contain their menstrual flow, young girls develop bodily odours that lead to social exclusion within peer groups thereby impacting negatively on their confidence (Wiegner 1987) [1, 2].

The need for affordable sanitary wear for women and girls in Africa is indeed a major public health issue that governments need to prioritize in their planning (Lynesther 2006) [3].
On the other hand, there is need for social innovation around this issue because the demand for sanitary wear is recurrent and continuously increasing with the population growth. Sanitary protection is an urgent need among women and girls and should be affordable, available and sustainable.

1.1 The concept of reusable homemade sanitary towel

The concept is to exploit locally available natural fibres as absorbent inserts in specially designed towels. The outer cover of the towel will be reusable while the inserts will be disposed after use. The towel is meant for women in the marginalized

Table 1: Standard sizes of sanitary towels.

Types	Width/mm	Length/mm
Full size towels	165	60
Mini pad	150	50
Panty liners	125	40

areas who have no access to and/or cannot afford commercial sanitary towels but have access to natural fibres like cotton and/or wool. This will encourage production and processing of cotton and wool in cottage industries and therefore contribute to poverty reduction and improvement of quality of life in the rural and marginalised areas. Women in cotton growing areas would be encouraged to grow cotton not only for commercial purposes but also for home use. In areas where cotton is currently not grown but has potential, women will be encouraged to produce it for their sanitary consumption. The harvested cotton will be ginned by hand and lint stored in a dry environment while seeds will be re-planted. In this ways a continuous supply of lint will be guaranteed throughout the year.

The reusable homemade sanitary towel should be comparable to commercial sanitary towel in terms of sizes, characteristics, structure, material requirement and performance. During the design stage all these factors were considered after studying the commercial sanitary pad. Some background information on characteristics, properties and standards of commercial sanitary towels are briefly explained below in order to understand the scope of this paper. The current paper addresses the issues of re-usable sanitary towel design and its usability. The actual field trials of the designed pads will be addressed in the subsequent paper.

2. COMMERCIAL SANITARY PADS

Sanitary towels are designed to absorb and contain body exudates. They are generally single-use or disposable items, which are placed against or in proximity to the wearer's body. There are three types of sanitary towels (Table 1) functionally defined as:

i) *Full size sanitary towels* **-** these are pads, which provide protection throughout the menstrual flow.
ii) *Mini pads* **-** pads, which provide protection during the light flow or tapering of the period.
iii) *Panty liners* **-** pads which provide inter menstrual protection that is absorbing small amounts of body discharge

Most commercial sanitary towels are not reusable and this makes them expensive and hence not affordable to poor women. The development of a reusable homemade towel will cut down the cost, ensuring its affordability.

2.1 Characteristics of sanitary towels

Commercial sanitary pads must fulfil the following requirements optimally and simultaneously [4]:

a) Reliable prevention of leakage
The sanitary care articles exhibit low leakage and have a dry feel for the wearer; otherwise their inability to the absorbent product to rapidly absorb fluids results in excessive pooling of the same on the pad's surface. Such pooled liquid wet the wearer's skin and leak, causing discomfort, potential skin health problems, as well as staining of the outer clothing of the wearer.

b) Insignificant detectable odour formation
The formation of odour is largely prevented by the moisture-tight and odour-tight sealing of the absorbed fluids in the interior of the hygienic towel.

c) Pleasant wearing with no skin Irritations
This is achieved by extensive shielding of skin from being in contact with the fluid. The pleasant, soft nature of the carrier material of the outer cover is fully retained even in the composite material by positioning the impermeable layer at the inner side of the towel.

d) Suitable size and volume
The towel is made thin and small without running the risk of saturating it. It should be invisible even when worn with light clothing. This is achieved by using a highly absorbent insert in the core of the towel.

e) Economic to manufacture
The hygienic towel should be economically manufactured and therefore reasonably priced.

2.2 Sanitary towel structure

The main components of a sanitary towel include [4]:

i) Cover stock/ outer cover
ii) Absorbent filler (core)
iii) Barrier film
iv) Core tissue

The cover stock serves to transport the body fluids quickly to the absorbent layer hence maintaining a dry feeling on the body surface. A variety of fabric structures and different fibre types are used for the cover stock. These include punched polyethylene resin, spun laid polypropylene fabrics, longitudinally oriented polyester webs treated with a hydrophilic finish, or random laid cellulosic webs, which are chemically bonded with an acrylic emulsion.

The barrier film is water impervious film made from either polyethylene or polyester. It prevents leakage of the absorbed body fluids.

The insert consists of folded tissue paper on which highly absorptive polymers have been applied. Generally the absorbent layer is a loosely compacted, highly porous structure composed of cellulose, usually bleached sulphite wood pulp, or super absorbent materials (Richard 2005) [5].It serves to absorb, usually at very high rate, and retain the body fluids hitherto absorbed while at the same time maintaining its integrity (Gitao and Mbeche 2009) [6].

2.3 Quality requirement for sanitary pads

a) Materials

The absorbent filler materials should be free from lumps, oil spots, dirt, foreign or and harmful materials. The covering of the absorbent filler should be of good quality cotton or rayon yarn knitted sleeve, gauze or non-woven fabric or other suitable material with sufficient porosity to permit the assembled pad to meet the absorbency requirements. Generally any material used to make sanitary towels must be non-toxic, non-allergic, biodegradable, and capable of being sterilized without imposing any changes in material's physical and chemical characteristics (Schmidtbauer 2002) [7].

b) Manufacture, workmanship and finish

The sanitary towels should have a non-absorbent barrier on the bottom of the filler. There should be an identifying thread or marking or sealing line on the side of the barrier. It should have a very soft and tender feel and when worn, they should not chafe or give any uncomfortable feeling.

c) Absorbency and retention

Sanitary towels, other than panty liners, should absorb a minimum of 7.2 millilitre of potassium dichromate solution directed onto the centre of the towel at the rate of 1.5 millilitres per minute, without seeping at the bottom or sides of the towel [4].

d) Acidity and alkalinity

Sanitary towels should neither be acidic nor alkaline when tested.

3. THE DESIGN OF A REUSABLE SANITARY TOWEL

The prototype sanitary towel consists of two parts, outer shell and the insert. For the insert, cotton and wool was used on the basis of their good water retention and imbibitions properties and therefore can be used as an absorbent material (Lina 2005) [8]. Wool is a hygroscopic fibre and can easily absorb up to 30% of its weight in moisture without feeling wet to touch. This unique ability allows it to remain comfortable even when wet; besides it has the ability to prevent build-up of odour (Cook 1984) [9].

3.1 Towel with re-usable outer shell and disposable insert

Outer shell

This is made up of the top cover, bottom cover and the barrier film as illustrated in Figures 1 and 2.

Figure 1: Outer shell top side for the proposed affordable and recyclable pad.

Figure 2: Outer shell bottom side for the proposed affordable and recyclable pad.

Top cover
In this sanitary towel polyester knitted fabric structure with minute eyelets is used as the top cover.
Bottom cover
Bottom cover is the outer part and is made of plain knitted polyester/cotton (65/35) material, making it comfortable to skin, cheap, smooth, strong and porous thus enhancing breathability of the sanitary towel.
Barrier film
The impermeable barrier film for preventing leakage is made of polyethylene material, which is cheap, less bulky, flexible, light and strong enough to withstand washing and frictional forces experienced during normal usage.

3.2 Manufacture of homemade sanitary towel

The concept consists of preparation of two parts: the recyclable outer layer and the disposable insert. A polyester/cotton fabric a designed, cut and folded with a piece of polythene film inside the fold to act as the barrier layer. The edges of the assembly are stitched together to form a pocket as illustrated in Figure 3.

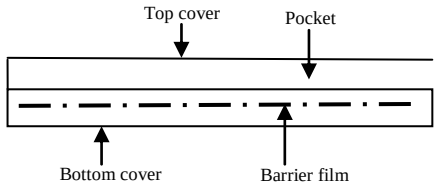

Figure 3: Cross sectional view of assembled parts that make up the proposed pad.

The complete sanitary pad is shown schematically in Figure 4.

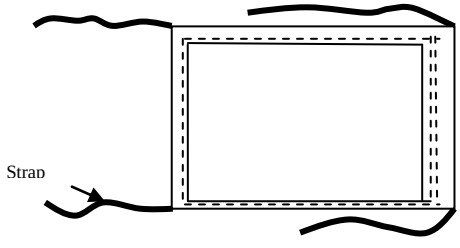

Figure 4: Final assembly showing straps to fasten the pad onto the body.

3.3 Insert material

For this towel, cotton and or wool fibres are used as the disposable insert. Seven grams of these fibres are inserted in the pocket provision of the outer shell in order to absorb and retain the released body fluids.
Cotton and wool fibres are produced in Kenya, especially in the arid and semi-arid areas, which form more than 75% of Kenya's landmass. Most regions produce cotton with the Coast province accounting for 44.7%, Eastern and Central provinces 32.8%, Western and Nyanza provinces 18.2% and Rift valley province 4.3% of the total cotton production. Commercial wool production is limited to Central and Rift valley only [10].

a) Preparing cotton inserts
The hand ginned cotton fibres are washed in a warm solution (60°C) containing soap or detergent. A liquor ratio of 1:5 is used. The fibres are then rinsed in a solution containing soap and then dried. This process removes the waxes on the fibres thus increasing cotton absorbency and at the same time leaving some detergent on fibres. This detergent makes fibre wetting easy therefore reducing the chances of fluid accumulation on the surface. This process also removes other impurities on the fibres making the product clean and hygienic. The cleaned, dried cotton fibres are then opened up through combing and stored in dry condition to prevent development of mildew.

b) Preparing wool insert
The raw wool is washed in a warm solution (60°C) containing sodium carbonate and soap. A liquor ratio of 1:5 is used. The scouring removes impurities making wool safer to use as sanitary material and also increasing its absorbency. Severe scouring is avoided so as not to remove all the natural lanolin in raw wool. The natural lanolin content of the wool keeps it hygienic - as the wool absorbs moisture, the lanolin is converted to lanolin-soap, which has an antibacterial effect [11]. The scoured wool is then rinsed properly and dried. The cleaned, dried wool fleece is then opened up through combing and stored in dry conditions.

3.4 Determination of water absorbency of wool and cotton fibres

Fibre absorbency was determined using a simplified Syngina Test [12]. A hollow glass tube was weighed and clamped vertically as shown in Figure 5. Scoured fibres of known weight were placed inside the tube. Distilled water was slowly added to the fibres from the top until a leakage was observed at the

underside of the fibres. The tube was then unclamped and weighed. The difference in weight was then calculated to determine water imbibitions.

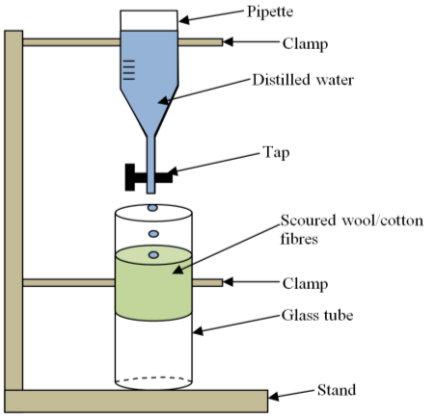

Figure 5: Schematic diagram showing a set-up for fibre's water absorbency determation.

The experimental results for cotton and wool samples tested are given in Tables 2 and 3 respectively.

Table 2: Cotton fibres water retention.

Trials	Dry mass (g)	Wet mass (g)	Retained Water mass (g)
1	5.02	11.23	6.21
2	5.03	11.2	6.17
3	5.04	11.94	6.9
4	5.02	11.19	6.17
5	5.07	11.98	6.91
Mean	5.04	11.51	6.47

Table 3: Wool fibres water retention.

Trials	Dry mass (g)	Wet mass (g)	Retained Water mass (g)
1	1.92	3.20	1.29
2	0.91	2.85	1.95
3	1.00	2.67	1.67
4	5.96	13.27	7.32
Mean	2.44	5.50	3.05

The average water imbibed per gram of fibres was calculated from the determined average values. For cotton, one gram of fibres imbibed about 1.24 grams of water while a gram of wool fibres imbibed about 1.25 grams.

3.5 Use, care and washing of the towel

To use the sanitary towel, cotton or wool fibres are inserted in the pocket. The towel is then fastened round waist firmly and kept in position by means of the straps.

After use, the fibres are removed and replaced with fresh ones. The used fibres can either be burnt or thrown into a pit latrine. The outer shell is soaked in cold water for some time and then washed. Soaking minimizes the chances of staining. Washing is carried out using detergent or soap. It is then boiled in water to sterilize, followed by proper drying in the open.

3.6 Cost of production analysis

For the reusable sanitary towel, it's assumed that 7grams of fibres will be required for each usage and replaced three times a day. Assuming the menstrual flow last four days per month, the total monthly and yearly fibre requirement is estimated at 84 and 1,008 grams respectively. Again, assuming two reusable towels are needed per lady per year, the following production costs are computed.

Direct costs per sanitary towel:

i) Polyester/cotton fabric costing: Cost of 0.0162m^2: Ksh. 1.8.
ii) Polyester fabric costing: Cost of 0.0162m^2: Ksh. 0.9.
iii) Fabric straps costing: Cost of 4 fabric straps: Ksh. 1.00.

Labour costs

i) Time taken per towel was 10 minutes.
ii) Number of working hours per day was 8 hours.
iii) Number of towels produced per day per worker: 48.
iv) Wage per day: Ksh. 200.
v) Labour cost per towel: Ksh. 4.00.

Table 4: Production cost summary per reusable sanitary towel

Details	Cost (Ksh.)
Polyester/cotton fabric	1.80
Polyester fabric	0.90
Polyethylene film	0.01
Fabrics straps	1.00
Thread	0.06
Labour	4.00
Total	7.77

3.7 Total cost of using homemade sanitary towel per year

3.7. 1 Using cotton fibres

i) Cost of two homemade sanitary towel is Ksh. 15.54
ii) Cost of treated fibres (1.01kg) realised from 3kgs of seed cotton (costing Ksh. 30 per kg - 2008 crop) is Ksh. 116
iii) The cost of washing the pads after use was Ksh. 6 per month hence yearly is Ksh. 72.
iv) Miscellaneous cost associated with the towel use is Ksh. 18
v) Total cost per year is Ksh. 221.54

3.7.2 Using wool fibres

i) Cost of two homemade sanitary towel is Ksh. 15.54
ii) Cost of treated wool fleece fibres is Ksh. 148 per kg.
iii) The cost of washing the pads after use was Ksh. 6 per month hence yearly is Ksh.72. Miscellaneous cost associated with the towel use is Ksh.18.
iv) Total cost per year is Ksh. 253.54.

3.8 Comparative cost analysis

To compare the cost of using the reusable homemade sanitary towel to the commercial pad, the following were assumed for commercial pads:

i) On average an individual uses sixteen pads in a month.
ii) A single pad retailed at Ksh. 5.63.
iii) Total yearly cost of using commercial pads is about Ksh. 1080.

The cost of making and using cotton-based reusable homemade sanitary towels per year would be Ksh. 221.54. This translates to a 79.5% saving on the cost of using commercial sanitary towels. For wool-based reusable towels costing 253.54, a 76.5% savings would be realised. For women rearing sheep or growing their own cotton, this would have an added savings since the cost of production is based on market prices for seed cotton and fleece respectively.

4. CONCLUSION

The reusable homemade sanitary towel was designed and developed consisting of two parts, the outer-shell and the disposable insert. The insert was made using natural locally available raw materials - wool and cotton fibres.

The fibres constituting the insert were made absorbent, and their performance determined using appropriate technologies. On average, seven grams of treated cotton and wool fibres imbibed up to 8.68ml and 8.75ml of distilled water, respectively. This compares reasonably well with fluid retention of 7.2ml per sanitary pad specified by KS 507:2005 Standards.

The ease of availability of the natural fibres in the marginalised areas (cotton grows in arid and semi-arid areas while wool sheep survive in harsh conditions) makes the process of using these fibres sustainable and affordable.

By making and using the reusable sanitary towel, women would stand to save between 76.5 and 79.5% savings depending on the available natural fibre used. At these prices, majority of marginalised women would be in a position to afford the towels.

REFERENCES

[1] Wiegner G. (1987). *Hygienic Sanitary Towel*. http://www.freepantentsonline.com [accessed 2 January 2009].

[2] Association of Women's Rights in Development (AWID), *Menstruation and gender disparities in education*, http://www.awid.org [Accessed 2 November 2008].

[3] Lynesther M. (2006). *Help on the way for maturing girls from poor families*. In East African Standard Newspaper:15/05/2006, Nairobi.

[4] Kenya Standard, KS 507:2005 *Sanitary towels - Specification for sanitary towels (Fourth Edition)*.

[5] Richard N. (2005). *Highly efficient surge material for absorbent materials*.

http://www.freepatentsonline.com [accessed 3 January 2009].

[6] Gitao V, Mbeche E. (2009). *The production of cheap and affordable sanitary towels using locally available resources*. In Moi University, Final year project, Eldoret.

[7] Schmidtbauer J. (2002). *A Star-Shaped Viscose Fiber For Improved Absorbency*. Viscostar,16-18.

[8] Lina P. (2005). *Emergency Situations*. http://www.mum.org/news.htm [accessed 2 January 2009].

[9] Cook JG. (1984). *Handbook of textile fibres*. Durban: Merrow

[10]Republic of Kenya. (1999). *Sessional Paper No.1 of 1999 on the Revitalization of the Cotton Industry,* , Nairobi: Government of Kenya.

[11]Many moons, *How to make your own washable sanitary towels*, http://www.stewardwood.org/resources/bottompad.gif [accessed 11 November 2008].

[12]http://www.lenzing.com/fe/media/LB-0812002015.pdf [accessed 10 November 2008].