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Full Length Research Article

Comparative Study of the Properties of some Non-Woven Diapers Manufactured in Nigeria

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ABSTRACT: The properties of locally made non-woven diapers were studied. Four locally made non-woven absorbent pads samples namely; Always ultra absorbent pad (sample A), Dr. Brown absorbent pad (sample B), Everyday ultra thin normal absorbent pad (sample C), and Enjoy leto absorbent pad (sample D) were analysed. They were subjected to physical and performance test such as weight, thickness, density, length/width, free absorbent capacity, fluid run-off quantification and pH test using standard equipment. The results obtained showed that diaper's length, width, and thickness affect the density of the diapers. This also greatly affects the free absorbent capacity of the diapers. Thus, sample D appeared to have the highest absorbent capacity than the rest of the absorbent pads, while sample A had the least absorbent capacity. There was also a variation in the fluid run-off, and the slight shift of the pH value from the neutral value (7.7-7.9).

Keywords: Absorbent, density, thickness, dimension, fluid run-off, pad

INTRODUCTION

Diapers are sponge-like garments which people wear, who are incapable of controlling their bladder or bowel movements, or are unable or unwilling to use a toilet. When diapers become full and can no longer hold any more waste, they require changing; failure to change a diaper on a regular basis can result in diaper rash (Krcma, 1971; Hornby, 1997).

A disposable diaper consists of an absorbent pad sandwiched between two sheets of non-woven fabric. The pad is specially designed to absorb and retain body fluids, and the non-woven fabric gives the diaper a comfortable shape and helps prevent leakage [Ohmura, 1995]. These diapers are made by a multi-step processes in which the absorbent pad is first vacuum-formed, and then attached to a permeable top sheet and impermeable bottom sheet (Ohmura, 1995; Rajpreet and Gita, 2004). The components are sealed together by application of heat or ultrasonic vibrations (Oldrich and Larry, 1999).

Diapers have been worn throughout human history, and made of cloth or disposable materials. Whereas cloth diapers are composed of layers of fabric such as microfibre and can be washed and re-used multiple times, disposable diapers contain absorbent chemicals and are thrown away after use (Ohmura, 1995; Lawal and Andrew, 2005). Currently, disposable diapers are the most commonly used. Plastic pants can be worn over diapers to avoid leaks, but this is no longer necessary.

Although some non-woven diapers are manufactured locally in Nigeria and used for various applications, their qualities need to be assessed so that a comparison can be made. In this present study, some locally made non-woven diapers were obtained. The properties of these diapers were analysed and their qualities assessed.

EXPERIMENTAL TECHNIQUES

Materials

Four different brands of diapers manufactured in Nigeria were purchased. These were: Always ultra absorbent pad (sample A), Dr. Brown absorbent pad (sample B), Everyday ultra thin normal absorbent pad (sample C) and Enjoy leto absorbent pad (sample D). The samples were tested for their thickness, weight, dimension, absorbent capacity/retention, fluid run-off quantification, and pH according to the method reported by Oldrich and Larry (1999) as described below.

Measurements of dimension of the diaper samples

The dimensional measurements of the diaper samples were done by carefully removing the outer wraps from the diaper. The inner non-wovens absorbing mass were weighed and the length and width of the samples were measured. The area of the diapers was calculated by multiplying the length with width.

Determination of thickness of the diaper samples

The elastics in the samples were removed and the products were laid flat. With the aid of a ruler, the centre of the samples were marked and a line drawn in the cross machine direction. 20 cm^2 circles were drawn with a marker, one at the front and the other at the back, at a distance approximately 1cm from the edge of the absorbent core. At each marked position, the sample circles were cut out with a press, and each punched sample was weighed and the weight recorded to the nearest 0.01g. The punched sample thickness was measured by placing it between two plastic discs and centering the sample on the micrometer base. The micrometer foot was lowered onto the sample and the thickness read.

Determination of pH of the diaper samples

The pH test was carried out using a JENWAY model 3310 pH meter. The non woven diaper (5.0 g) was weighed and cut-out around the dosing zone in the baby nappy, and 2.5 g from the sanitary pads. The samples were weighed and placed in separate 250 ml flat bottom flask and 125 ml warm distilled water was added to the sanitary pads and allowed to stay for 1 h. The pH meter electrode was placed into the flask and the reading recorded.

Determination of density of the diaper samples

The area of the sample punched out from the sanitary pad samples is 10cm^2. The thickness was recorded in cm, the standard deviation (S.D) and the coefficient of variation (C.V%) were calculated and recorded. The density in g/cm^3 of the samples was also calculated as follows:

$$\text{Density}(\text{gcm}^{-3}) = \frac{\text{Sample weight(g)}}{\text{Area}(\text{cm}^2)\ \text{x Thickness(cm)}} \text{(Krcma,1971)}$$

Determination of absorbent capacity of the diaper samples

Saline solution was prepared by mixing distilled water with regular table salt at 0.9% concentration. The dry diapers were weighed and their weights recorded. The saline solution was poured into a large container and the diaper was placed flat upside down at the bottom of the container and thereby absorbing the saline solution. It was allowed to stay in the container for 30 min.. No additional pressure was applied to the diaper as it was soaking the solution. After the 30 min., the diapers were removed. They were allowed to drip for 10 min. by hanging them with cloth pins at the corners in such a way that they dripped vertically. After 10 min., the weight was measured. The absorbent capacity is the difference between the two recorded weights (i.e. wet weight – dry weight). The best diaper for this performance attributes is the one with the highest absorbent capacity as illustrated in Figure 2.

Determination of fluid run-off quantification of the diaper samples

This test was carried out to quantitatively determine the surface effect of non-woven diapers. 0.9% saline solution was prepared as described previously and a few drops of food dye added and thoroughly blended. The diaper samples were weighed and their weights recorded to the nearest 0.01g. The diaper was cut in half, and the end opposite the center was secured with clipboard clamp and the cut end taped to the clipboard surface, creating a seal. It was pulled firmly to reduce folds and kinks on the product surface. The fluid dosing position was marked 10 cm above the top edge of the masking tape. A separatory funnel was clamped with the spigot 1cm above the pre-marked dosing position and the timer was set for 10 min., 25 ml of 0.9% saline solution was dispensed into the separatory funnel. The balance was positioned at the bottom of the 30^o incline table with a folded paper towel on the weighing surface to contain any fluid that runs off. The scale was set at zero and the separatory funnel tap was opened. The paper towel absorbed any fluid that run-off. The run-off weight was recorded to the nearest 0.01grams. This is called the primary run-off value. After 10 min. interval, the steps were repeated with a new paper towel and the run-off weight was called the secondary run-off value. After another 10 minutes interval, the process was repeated with a new paper towel and this run-off weight is called the tertiary run-off value. The average run-off value and the standard deviation of the run-off values were calculated.

RESULTS AND DISCUSSION

The results of the various parameters studied are recorded in Table 1 and Figures 1, 2 and 3. The results in Table 1, gives the dimensions of the diaper samples. The sample weight indicates that, sample D had the highest weight, while sample C had the least weight. The area of the diaper samples indicated that sample A had more area; the decreasing order of the diaper area is given as A>B>C>D. The area of the diaper is an expression of how good the diaper will cover to prevent fluid leakage. Therefore, the coverage to prevent leakage of fluid decreased in the order A>B>C>D. As shown in Table 1, the diapers' thickness decreased in the order D>B>A>C. The decreasing order of thickness expressed in standard deviation is given as D>C>A>B, and that of coefficient of variation was D>C>A>B.

As indicated in Table 1, all the diaper samples have pH values of 7.7-7.9. The shift of the pH value from its neutrality position was an indication of incomplete rinsing of the scouring reagent after fibre scouring.

The results illustrated in Figure 1 indicate the density in g/cm^3 of each diaper sample. The densities of the diapers are in the order C>A>B>D. Thus, sample C had the highest density. The higher the density of non woven diapers, the more fibres per unit volume and the higher the inter- fibres contact; the closer the fibres are to each other, the more they assist the attraction of liquid surface to solid (capillary) and even fluid spreading (Ohmura, 1995).

The results shown in Figure 2, gives the diaper absorbent capacity which is the maximum amount of the liquid that can be soaked-up and held by the diaper sample. Thus, sample D had the highest absorbent capacity. The decreasing orders of the absorbent capacities of the diaper samples are given as D>C>B>A. The best sample for this performance attribute is the one with the highest absorbent capacity.

From the illustration in Figure 3, the diaper fluid run-off quantification which is the quantitative evaluation of the surface effect of the non- woven diapers, it also indicates the speed of absorption of fluid by the diaper (Oldrich and Larry, 1999). The result showed that sample D had the least run-off value. The increasing order of the fluid run-off values are given as; D<B<C<A. The best sample for this performance attribute is the one with the least fluid run-off values, which was sample D.

Table 1: Measurement of the dimensions of diaper samples, Thickness of the non-woven diapers and pH of the diapers

Diaper Sample	Sample Weight (g)	Dimensions		Area (cm^2)	Thickness (cm)	CV	pH
		Length (cm)	Width (cm)				
A	6.65	26.00	7.00	182.0	0.2920 ± 0.1288	21.20	7.7
B	7.83	25.20	7.20	181.4	0.3866 ± 0.0902	14.85	7.7
C	5.50	24.10	6.80	163.9	0.2333 ± 0.1528	25.15	7.7
D	9.34	19.17	6.90	132.3	1.0667 ± 0.1874	30.84	7.9

CV = coefficient of variation

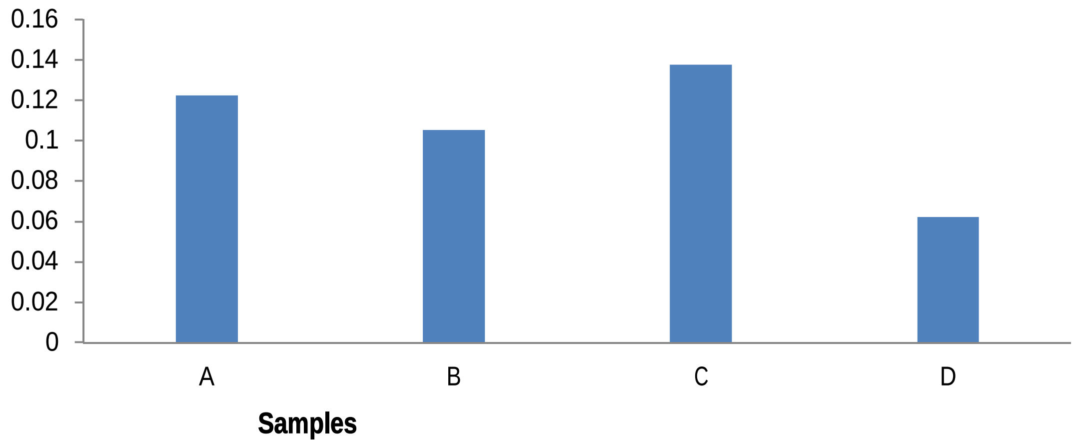

Figure 1: Graph of density versus samples

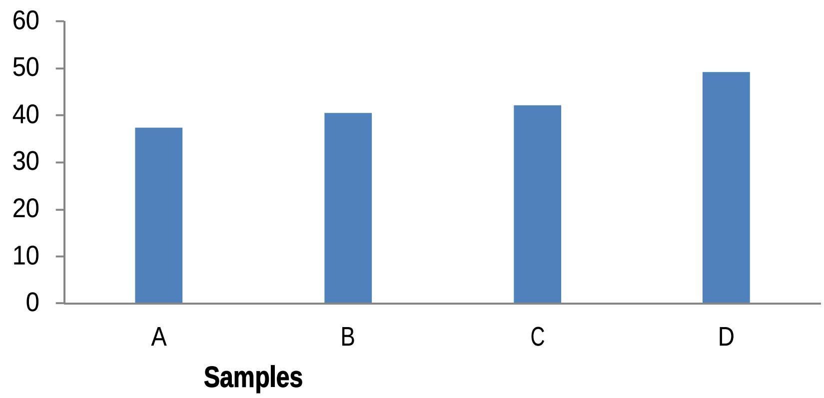

Figure 2: Graph of absorbent capacity versus samples

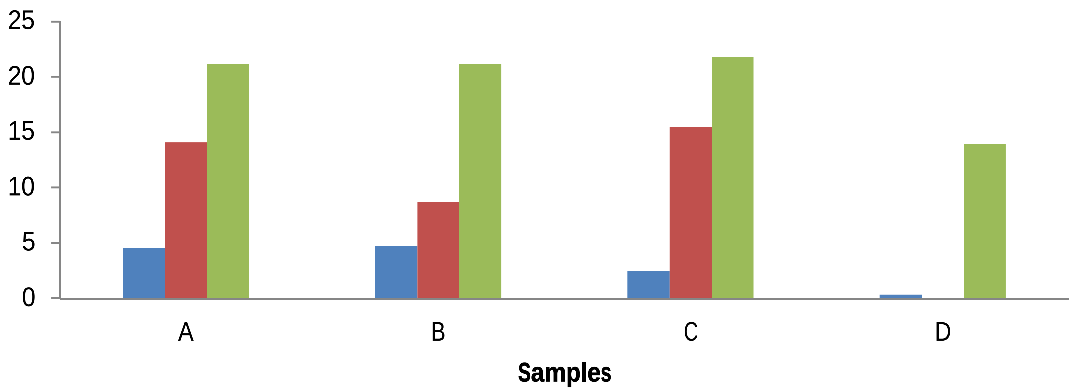

Figure 3: Graph of run-off values versus samples

CONCLUSION

It can be concluded from the results obtained that no two different identical diaper brands had the same properties. There were some small variations in the properties tested, and this may be due to the process control variations in the diaper production line. The absorbent capacity/retention of the diaper samples also differed as a result of the differences in their densities. Thus, sample D appeared to have the highest absorbent capacity than the rest of the absorbent pads, while sample A had the least absorbent capacity. The fluid run-off quantification also showed some level of differences in the samples which were as a result of the different speed of absorption and the top permeable outer wrap of the samples.

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