IJPPR
INTERNATIONAL JOURNAL OF PHARMACY & PHARMACEUTICAL RESEARCH
An official Publication of Human Journals
ISSN 2349-7203
HUMAN

Human Journals
Research Article
May 2023 Vol.:27, Issue:2

Preparation and Evaluation of Eco-Friendly Herbal Sanitary Napkins

IJPPR
INTERNATIONAL JOURNAL OF PHARMACY & PHARMACEUTICAL RESEARCH
An official Publication of Human Journals
ISSN 2349-7203
HUMAN

Kavitha.V[1]*, Shri Vijaya Kirubha.T[2], Senthamarai.R[2], Balasubramanian.P[3]

[1]Assistant Professor, Department of Pharmacognosy, Periyar College of Pharmaceutical Sciences, Tiruchirappalli, India

[2] Professor, Department of Pharmacognosy, Periyar College of Pharmaceutical Sciences, Tiruchirappalli, India

[3]Associate Professor, Department of Pharmacognosy, Periyar College of Pharmaceutical Sciences, Tiruchirappalli, India

Submitted: 23 April 2023
Accepted: 29 April 2023
Published: 30 May 2023


www.ijppr.humanjournals.com

Keywords: Plant fibres, Herbal Sanitary Napkin, Evaluation parameters

ABSTRACT

The paper focuses on developing an eco-friendly sanitary napkin, with multilayer construction by using biodegradable resources. Commercial pads are non biodegradable causing accumulation of menstrual waste and degradation of environment. A study estimated that on an average 335 million menstruating women dispose 432 million pads every month. These sanitary pads are non-biodegradable and remain in the landfills for about 800 years. Commercial sanitary napkins contain chemicals which affects the health status of women. The best alternative for these synthetic materials are agricultural and plant based fibers as they are abundant, non toxic, environmental friendly and bio degradable. The purpose of the research work focuses on preparation of three different combinations encompassing fibres of plant origin viz., Aloes, Pineapple and Banana as core layer by sandwiching with SAP (Super Absorbent Polymer) sheets. The following three different types of combinations: Cotton & Aloe / Cotton & Pineapple / Cotton & Banana were prepared as organic sanitary pads. Biodegradable polyethylene plastic was used as barrier layer. The performance of sanitary napkin was assessed by absorption capacity, leakage test, strike through and wet back test. Herbal extract of Neem was incorporated on the fibres and used as antimicrobial agent. It was revealed from the results that sanitary pad made of pineapple core with Neem extract finished top sheet showed best menstrual hygiene performance.

1 INTRODUCTION

Menstruation is the process where women undergo blood discharge from the lining of uterus at an interval between 28 to 35 days. Over centuries, women have used various adsorbent materials like fabric, leaves, etc., in order to absorb the blood discharge. Usage of such materials highly impacts menstrual hygiene. Evolution of sanitary napkins from Nineteenth century has slowly replaced the use of old fabrics, leaves etc., during menstruation. Most of the commercially available sanitary napkins are made up of synthetic material and Super Adsorbent Polymers (SAP). These materials are non-biodegradable in nature and add to pollution load due to improper disposal and waste management. These synthetic non-biodegradable materials are not only a threat to the environment but also a serious threat to the user itself. Use of such sanitary napkins is also one of the identified risk factor for the reason behind cervical cancer. The raw materials used in commercial sanitary napkins focuses mainly on absorbing blood fluids, surface dryness for comfort, odour free fragrance finish and compactness of napkin for wearers comfort whereas least importance is given for environment and human health. Serious health risks for the wearer have been reported due to the harmful chemicals and fragrance used in commercial sanitary napkins. Another issue is the cost of the sanitary napkin which is far from the economical level of average and below average community in the country. Most of the population is unaware of proper disposability of sanitary napkin after usage. Reports claim that these sanitary napkins once thrown in the environment takes around 100 years for decomposition. The amount of sanitary napkins used over a period of years causes landfills that even exceed a metropolitan land area and causes passive problems to people handling the waste [1].

Problems associated with commercial sanitary pads

The materials used in commercial sanitary napkins are generally petroleum-based and cannot be reused. The globe is dealing with a significant problem caused by the carbon footprint of sanitary pads, which emit gases into the atmosphere. Due to the availability and abundance of wood pulp, it is the major raw material used in feminine hygiene products. Over exploitation of trees will lead to deforestation and have an adverse effect on the environment. Cellulose bleached pulp, super absorbent polymer, rayon, dioxin, artificial fragrances and petrochemicals used in sanitary napkins cause skin irritation, allergies, toxic shock syndrome and ovarian cancer.

Synthetic materials used in pads block dampness and heat, increasing the risk of yeast and bacterial infection. Sanitary pads are made of non-biodegradable plastic materials, which increase menstrual waste and pollute the environment. Furthermore, it creates an occupational hazard because the workers pick up this garbage with their bare hands. Environmentalists have stressed on the fact that used sanitary pads are a big threat to the environment. This is mainly due to the chemicals that are present in them [2].

Dioxin

Sanitary pads are not naturally pure white. The fibres in pads are chlorine bleached to give them their clean and sterile appearance. This bleaching process creates dioxin, a highly toxic pollutant. Dioxin accumulates in the fat stores of the body over time, and can stay there for upto 20 years. Exposure to dioxin can lead to pelvic inflammatory disease, hormone dysfunction, endometriosis, and various forms of cancer.

Pesticides

Conventionally grown cotton is heavily sprayed with pesticides and herbicides, and these chemicals can stay on the cotton long after it has been harvested**.** Side effects of exposure include infertility, hormonal disruption, thyroid malfunction, diabetes, endometriosis and depression.

Plastics

Sanitary pads often advertise themselves as 'leakproof', with an impermeable plastic layer at the bottom of pads which do not allow liquid or air to pass through. The plastic traps moisture and heat**,** creating an environment that promotes the growth of yeast and bacteria**.** It can also cause sensitive individuals to experience burning, chafing and soreness.

Fragrances

Scented sanitary pads with odour neutralizers and other artificial fragrances contain a combination of unknown chemicals, which can enter the bloodstream and cause side effects. On the surface, they also irritate the skin, causing allergies and reactions [3].

Possible Health Hazards of Commercial Sanitary Napkins [4]

The chemicals used in the making of sanitary napkins can enter the bloodstream and wreak havoc on the health. Some of the potential health hazards of sanitary pads include

- Cancer in the ovaries
- Infertility
- Hormonal dysfunction
- Rashes
- Vaginal allergies
- Inflammation in the pelvic region
- Damaged immune system
- Malfunctioning of the thyroid
- Ailments related to the endometrium

The current study focuses on developing natural fibre sanitary napkins in terms of absorbency, comfort properties and herbal protection. These fibres isolated from the plant source are the good resource which has higher absorbency, economical, soft feel and has anti microbial properties which help the menstruating women relieve from pain and infection. These fibres in combination with cotton results in fine tuned properties suitable for the production of sanitary napkin. In addition to the extensive benefits gained from these fibres being used as absorbent core, the top layer of the sanitary napkin is further finished with neem extract for additional antibacterial protection.

On an overview, our work was aimed on producing sanitary napkin with the help of natural raw materials which results in user friendly and cost effective product which enables in production of napkins.

2 MATERIALS

Collection of Plant material

The fibres were collected from the following places

Banana fiber - Karumandabam, Trichy

Pineapple fiber - Alwarthirunagar, Chennai

Aloe fiber - Kottaikadu, Pudukkottai

Banana fiber, Pineapple fiber, Aloe fiber, organic cotton, muslin cloth were used as a source of material. These fibers are naturally occurring material and completely degradable and pose no side effect to humans and environment. Organic cotton as top layer is one the generally prompted crude material in pad due to its non aggravation, tissue-friendly and prevalent fluid maintenance properties. Cotton material keeps away moisture and keeps skin dry and makes skin comfort[5]. Neem powder was subjected to ethanolic extraction to top the prepared napkin for its anti microbial property.

2.1 Method of preparation

Fibers of various plants such as pineapple, banana and aloe were collected and then kept aside in equal proportion. Neem extract was prepared using alcohol and the processed fibres were dipped in it and dried. The napkin base was prepared using cotton then the processed plant fibers were inserted between the cotton base and was draped using a muslin cloth and stitched.

Preparation of Sanitary Napkins

FIGURE NO. 1: PROCESSED FIBRES COATED WITH NEEM EXTRACT

Synthetic blood was prepared to simulate menstrual blood to evaluate actual performance of sanitary pad by the following methods.

Preparation of Artificial blood

The artificial blood used for testing of sanitary napkin was prepared using 1.0 % w/v of Sodium chloride, 0.4 % w/v of Sodium carbonate, 10 % w/v of glycerol, 0.5 % w/v of carboxy methyl cellulose and 90% w/v de-ionized water, congo red 0.001g.

3 EVALUATION TEST

3.1 Absorbency Capacity [6, 7]

The absorbency capacity was measured according to EAS 96:2008-Annex C standard, using artificial blood as test fluid. Initially, dry weight of sample was taken and then fluid poured on it until saturation was reached. On reaching saturation 3.4 kg weight was placed over it and blotted with filter paper to remove the excess fluid and pad weighed. Absorption capacity was calculated by the following formula:

$$\text{Absorption capacity} = (X\text{-}W)$$

X= Dry weight of pad

W= Final weight of pad after saturation

3.2 Vertical Wicking

Test was carried out according to AATCC TM 197-2011 standard. It determines the ability of pad to take up fluid against gravity at a given time. One end of test sample (25mm x 170mm) was clamped vertically and the other end was immersed in test fluid to about 2mm height. The rate of fluid (distance per unit time) traveled along the specimen was visually observed and recorded at interval of 1, 2,5,10,15,20,25 and 30 mins.

3.3 Strike Through

A drop of test solution was allowed to fall on the sample (125mm X 125mm) and the time taken for the solution to transport from the upper layer of the napkin to the inner layers of the sample was measured. The instrument is so designed that it releases a standard 5cc saline solution into cavity through a star-shaped opening in the bottom of the well that rests on the

test piece, liquid drains through the test piece into an absorbent pad. The strike through time was measured in seconds.

3.4 Wet back

This method is used to examine the ability of pad to resist the transport back onto skin of a liquid which has already penetrated the cover stock. 20ml of test fluid was poured onto the sample, apre-weighed filter paper was placed over the sample and a weight of 3.4kg was placed over it for 3 minutes and the filter paper reweighed. The difference in the weight of filter paper expressed in grams is known as wet back.

3.5 Leakage Proof Experiment

The test was carried out according to EAS 96:2008-Annex B standard. It determines the efficiency of barrier layer. A specimen size of 6.5cm X 6.5cm barrier sheet was cut and folded into a cone and placed in a funnel. The funnel filled with test fluid was kept for 48hrs, and then checked for any leakage.

3.6 Antibacterial Activity Test [8,9]

Staphylococcus aureus- 902 and E.coli- 443 were purchased from MTCC, Chandigarh, India. Nutrient Agar medium, Nutrient broth, Gentamicin antibiotic solution were purchased from Himedia, India. Test samples, petri-plates, test tubes, beakers conical flasks were from Borosil, India. Spirit lamp, double distilled water.

Agar- Well Diffusion Method

a. Nutrient Agar Medium

The medium was prepared by dissolving 2.8 g of the commercially available Nutrient Agar Medium (HiMedia) in 100ml of distilled water. The dissolved medium was autoclaved at 15 lbs pressure at 121°C for 15 minutes. The autoclaved medium was mixed well and poured onto 100mm petriplates (25-30ml/plate) while still molten.

b. Nutrient broth

Nutrient broth was prepared by dissolving 2.8 g of commercially available nutrient medium (HiMedia) in 100ml distilled water and boiled to dissolve the medium completely. The

medium was dispensed as desired and sterilized by autoclaving at 15 lbs pressure (121ºC) for 15 minutes.

PROCEDURE

Petri plates containing 20 ml nutrient agar medium were seeded with 24 hr culture of bacterial strains and adjusted to 0.5 OD value according to McFarland standard, (*Staphylococcus aureus- 902 and E.coli- 443).* Wells were cut and concentration of sample Pineapple fibre(PF), Banana fibre (BF) and Aloe fibre (AF) (100 µl-DMSO) was added. The plates were then incubated at 37°C for 24 hours. The antibacterial activity was assayed by measuring the diameter of the inhibition zone formed around the wells. Gentamicin antibiotic was used as a positive control. The values were calculated using Graph Pad Prism 6.0 software (USA).

3.7 ANTIFUNGAL ACTIVITY [10, 11]

Materials Required

Potato dextrose agar medium, Amphotericin B antimycotic solution, test samples, test tubes, beakers conical flask, spirit lamp, double distilled water and petri-plates.

AGAR- WELL DIFFUSION METHOD

Potato Dextrose Agar Medium

The potato dextrose agar medium was prepared by dissolving 20 gm of potato infusion, 2 g of dextrose and 1.5 g of agar in 100ml of distilled water. The dissolved medium was autoclaved at 15 lbs pressure at 121°C for 15 minutes. The autoclaved medium was mixed well and poured onto 100mm petri plates (25-30 ml/plate) while still molten.

Petri plates containing 20ml potato dextrose agar medium was seeded with 72 hr culture of fungal strain*(Candida albicans* and *Aspergillus niger)* wells were cut and different concentration of sample AF, PF and BF (100 µl-DMSO) was added. The plates were then incubated at 28°C for 72 hours. The anti-fungal activity was assayed by measuring the diameter of the inhibition zone formed around the wells. Amphotericin B was used as a positive control. The values were calculated using Graph Pad Prism 6.0 software (USA).

4 RESULTS AND DISCUSSION

The present work deals with preparation and evaluation of Biodegradable Sanitary Napkin. Absorbency range, Leakage factor, Vertical Wicking test, Strike through test & Antibacterial test were evaluated for Aloe fibre, Banana fibre & Pinapple fibre coated with Neem extract.

Absorbency range

The absorbency range showed that the Pineapple fibre had satisfactory absorbance capacity compared to the other two fibres. The results are tabulated in Table 1.

FIGURE NO. 2: FINISHED MATERIAL FOR ABSORBENCY TEST

TABLE NO. 1: ABSORBENCY RANGE

Sample	**Initial Wt(g)**	**Final Wt(g)**	**Finished Product Absorbency (%)**
Aloe fibre	4.55	15.76	71
Banana fibre	4.37	14.03	68
Pineapple fibre	11	40.72	72.9

Leakage factor

The leakage test results showed that the Pineapple fibre had very less leakage factor when compared to other two plant fibre containing napkins. The results are tabulated in Table 2.

FIGURE NO. 3: FINISHED MATERIAL FOR LEAKAGE TEST

TABLE NO. 2: LEAKAGE FACTOR

Sample	Initial Wt. (g)	Final Wt. (g)	Leakage Factor (%)
Aloe fibre	0.76	0.82	7.89
Banana fibre	0.68	0.72	5.8
Pineapple fibre	0.70	0.74	5.71

Vertical Wicking test

In the vertical Wicking test the pad made with Pineapple fibre had good Wicking property when compared to the Banana & Aloe fibre made pads. The results are tabulated in table 3.

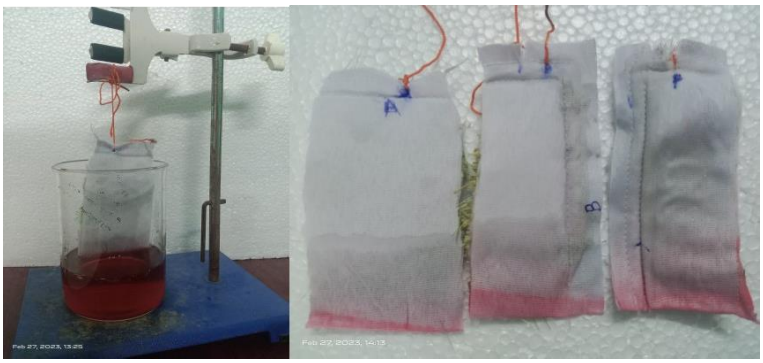

FIGURE NO. 4: VERTICALWICKING TEST

TABLE NO. 3: VERTICAL WICKING TEST

Sample	Aloe Fibre	Banana Fibre	Pineapple Fibre
Time (Min.)	Distance Travelled(cm.)	Distance Travelled(cm.)	Distance Travelled(cm.)
1	1.4	1.5	0.8
2	1.6	1.8	1.4
3	2.2	2	2
5	2.6	2.6	3
10	2.8	2.8	3.6
15	2.9	2.9	4
20	3.2	3.2	4.7
25	3.6	3.6	5.4
30	4	4	6.7

Strike through test

There is a significant difference between the three sanitary pads made with plant fibres. The strike through for the Pineapple fibre was very high strike when compared to other two plant fibres. The results are tabulated in Table 4.

FIGURE NO. 5: STRIKETHROUGH TEST

TABLE NO. 4: STRIKETHROUGH TEST

Sample	Time (Min)
Aloe fibre	35
Banana fibre	47
Pineapple fibre	74

ANTIMICROBIALACTIVITY

In Antimicrobial activity, the Banana fibre showed powerful antibacterial activity & Pineapple fibre showed potent antifungal activity when compared to the positive control. The following pictures showed the Antimicrobial activity of the fibres and the zone of inhibition are tabulated in Table 5 & 6.

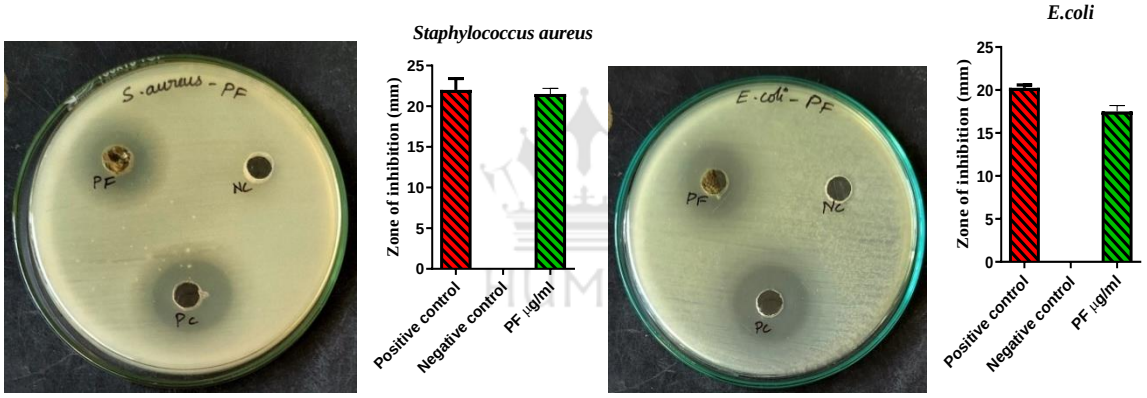

FIGURE NO. 6: EFFECT OF SAMPLE PF AGAINST *STAPHYLOCOCCUS AUREUS* & *E. COLI*

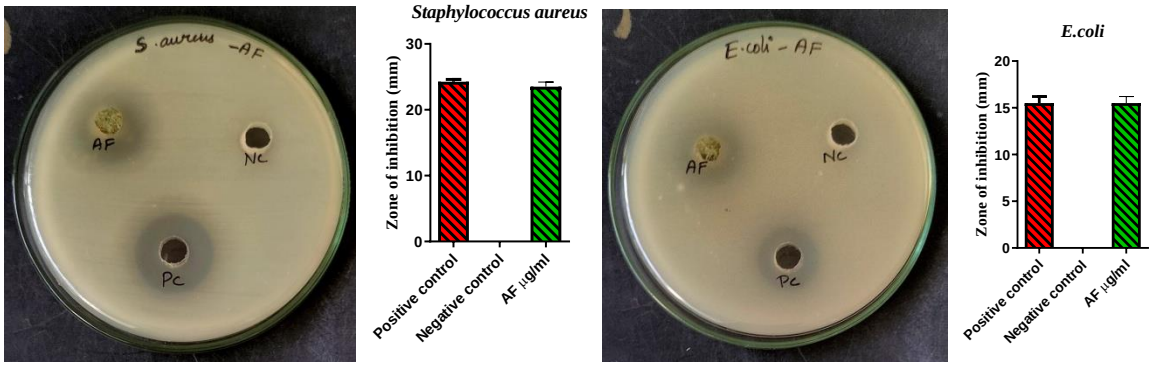

FIGURE NO. 7: EFFECT OF SAMPLE AF AGAINST *STAPHYLOCOCCUS AUREUS* & *E. COLI*

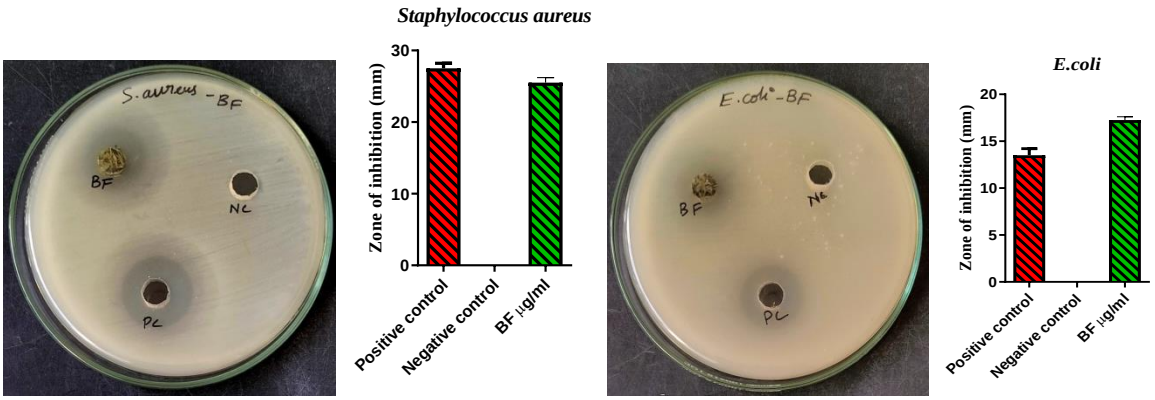

FIGURE NO. 8: EFFECT OF SAMPLE BF AGAINST *STAPHYLOCOCCUS AUREUS* & *E.COLI*

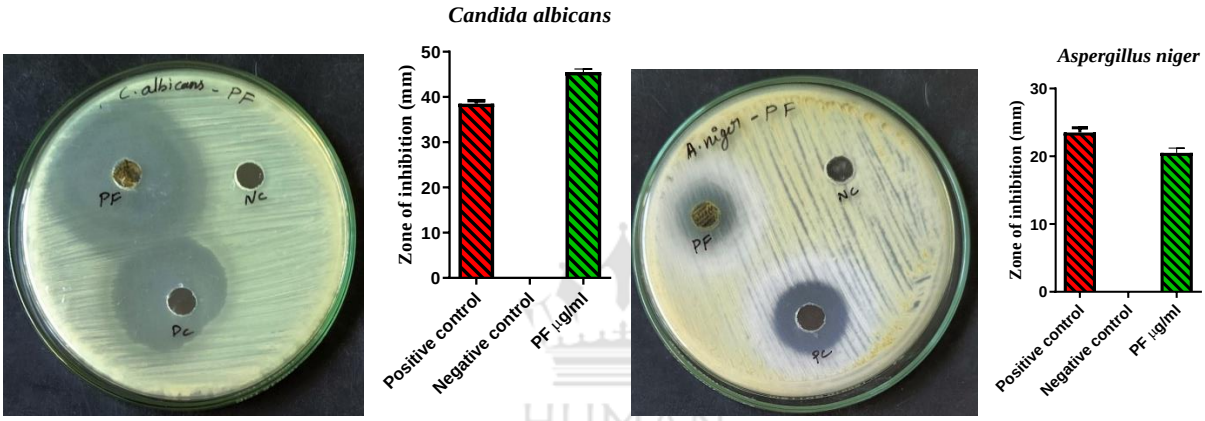

FIGURE NO. 9: EFFECT OF SAMPLE PF AGAINST *CANDIDA ALBICANS* & *ASPERGILLUSNIGER.*

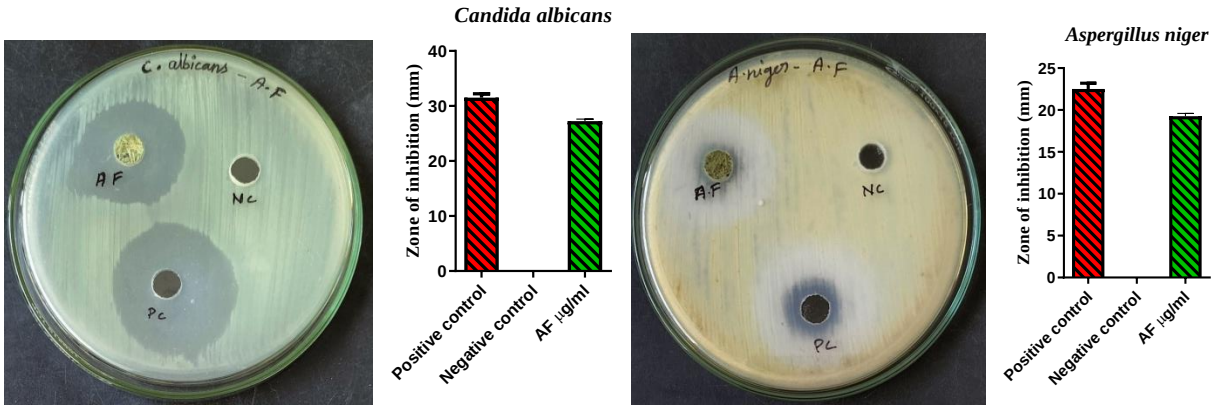

FIGURE NO. 10: EFFECT OF SAMPLE AF AGAINST *CANDIDA ALBICANS* & *ASPERGILLUS NIGER*

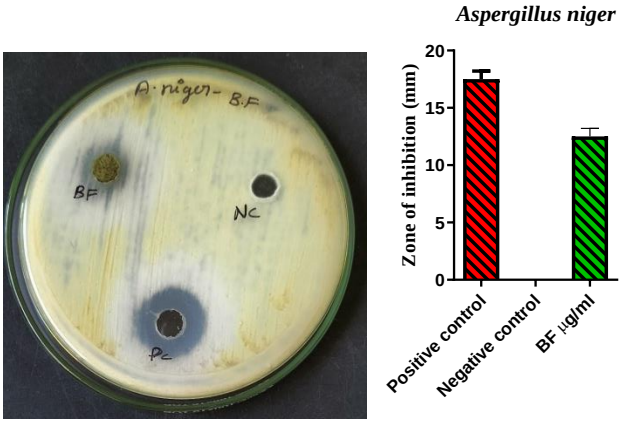

FIGURE NO. 11: EFFECT OF SAMPLE BF AGAINST *ASPERGILLUS NIGER.*

TABLE NO. 5: ANTIBACTERIAL ACTIVITY OF PROCESSED FIBRE

S. No.	Name of the test organism	Test Sample Concentration	Zone of inhibition (mm) SD ± Mean			
			PF µg/ml	AF µg/ml	BF µg/ml	PC
1.	*Staphylococcus aureus*	100 µl	19.25±0.35	23.5±0.7	25.5±0.707	24.42±0.588
2.	*E. coli*		17.5±0.707	13.25±0.35	17.25±0.35	16.42±0.586

TABLE NO. 6: ANTIFUNGAL ACTIVITY OF PROCESSED FIBRE

S. No.	Name of the test organism	Name of the test sample Concentration	Zone of inhibition (mm) SD ± Mean			
			PF µg/ml	AF µg/ml	BF µg/ml	PC
1.	*Aspergillus niger*	100 µl	20.5±0.707	19.25±0.35	12.5±0.70	21.16±0.7
2.	*Candida albicans*		45.5± 0.7071	27.25±0.35	-	35.5±0.70

5 CONCLUSION

From the above results, it can be concluded that Herbal sanitary napkins prepared from Banana, Aloes and Pineapple fibres shall serve as a good alternative for synthetic sanitary napkins and can be effectively used in manufacturing of biodegradable sanitary napkins. Isolated plant fibres in combination with cotton fibres provided added advantage in sanitary napkin properties. Cotton possesses inherent properties such as good absorbency which can be beneficial to the absorbent core in combination with plant fibres which results in higher efficacy of the produced Development of Eco-friendly Herbal Sanitary Napkins using Cotton with plant fibres.

The herbal antimicrobial finish using Neem on top layer of sanitary napkin further enhances the antimicrobial protection to the user. Three different Sanitary napkins had been prepared in combination with fibers of cotton and Aloe, Cotton and Banana, Cotton and Pineapple respectively. From the evaluation parameters and anti-bacterial activity it may be concluded that the Cotton and Pineapple made sanitary napkin showed better performance among the prepared napkins. Thus, the developed cotton-pineapple sanitary napkin can be an effective alternative for synthetic napkins available in the market. The developed herbal sanitary napkin would be more beneficial and ecofriendly for a healthy society.

6 REFERENCES

[1] Tharakeswari. S, Barshana. S, Indhu. R, Vinu Arthi. M, Yuga bharathy. B. Development of Eco-friendly Herbal Sanitary Napkins using Cotton and Kenaf Fibres.International Journal of Mechanical Engineering.2021;6(3):224-229.

[2] Srikavi Anbalagan, Mekala. M. An Overview of the Plant Fibres in the Development of Ecologically Sustainable Sanitary Napkins for the Green Economy. Journal of University of Shanghai for Science and Technology. 2021; 23(8): 161 -172.

[3] Gee Ann, The Period CO. June 12, 2022 available from https://www.theperiod.co/blogs/news/5-ways-sanitary-pads-are-killing-you.

[4] Chanchal Sengar, Only my health Apr 09, 2021 available from https://www.onlymyhealth.com/know-the-side-effects-of-using-sanitary-pads-1614144359Health Dangers of using Sanitary Pads.

[5] Naseem Ullah, Muhammad Zahoor, Farhat Ali Khan, Shazeb Khan. A review on general introduction to medicinal plants its phytochemicals and role of heavy metal and inorganic constituents. Life Science Journal 2014; 11(7): 520 -527.

[6] Dhinakaran M, Senthil C S, Sathish T K. Development and characterization of sanitary napkins with Lyocell/Modal as absorbent core. International Research Journal of Engineering and Technology. 2017; 4:1003-1006.

[7] Reshma A, Priyadarisini V. B, Amutha K, Sustainable Antimicrobial Finishing of Fabrics Using Natural Bioactive Agents - a Review. Int. J. Life Sci. Pharma Res., 2018;8(4):10–20. doi:10.22376/ijpbs/lpr.2018.8.4.l10-20

[8] Bauer, A. W. Roberts C. E., Kirby W. M. Single disc versus multiple disc and plate dilution techniques for antibiotic sensitivity testing. Antibiotics annual. 1959; 7: 574-580.

[9] Bauer, Alfred W, David M. Perry, William Mm Kirby. Single-Disk antibiotic-sensitivity testing of *staphylococci*: An analysis of technique and results.AMA archives of internal medicine. 1959; 104(2): 208-216.
[10] DeMagaldi, Silvia W., and Teresa Camero. Suceptibilidad de *Candida albicans*: *In vitro* mediante los posos de difusion. *In Vitro* antifungal susceptibility of *Candida albicans* intervening the diffusion well Bol. venez. Infectol. 1997; *7(1):*5-8.
[11] John H. Barbara D. Alexander, David Andes, Beth Arthington.Clinical and Laboratory Standards Institute. Reference method for broth dilution antifungal susceptibility testing of yeasts. Approved standard M27-A3; Third edition: 2008.

 *Image* *Author -1*	**Kavitha.V*** ***Corresponding author** Assistant Professor, Department of Pharmacognosy, Periyar College of Pharmaceutical Sciences, Tiruchirappalli, India
Image *Author -2*	**Shri Vijaya Kirubha.T** Professor, Department of Pharmacognosy, Periyar College of Pharmaceutical Sciences, Tiruchirappalli, India
Image *Author -3*	**Senthamarai.R** Professor, Department of Pharmacognosy, Periyar College of Pharmaceutical Sciences, Tiruchirappalli, India
Image *Author -4*	**Balasubramanian.P** Associate Professor, Department of Pharmacognosy, Periyar College of Pharmaceutical Sciences, Tiruchirappalli, India