EUROPEAN JOURNAL OF BIOMEDICAL AND PHARMACEUTICAL SCIENCES
http://www.ejbps.com

ISSN 2349-8870
Volume: 9
Issue: 10
247-251
Year: 2022

A NOVEL APPROACH: BIODEGRADABLE SANITARY NAPKIN BY COW DUNG

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Article Received on 03/08/2022 **Article Revised on 23/08/2022** **Article Accepted on 13/09/2022**

INTRODUCTION

Sanitary napkin: A sanitary napkin, sanitary towel, sanitary pad, menstrual pad, maxi pad, or pad is an absorbent item worn by a woman while menstruating, recovering from vaginal surgery, lochia (post-birth bleeding), abortion, or any other situation where a flow of blood from a woman's vagina is required to be absorbed. (L., 2001).

Types of sanitary products

(a) Reusable and Washable cloth pad
(b) Commercial sanitary pad
(c) Tampons
(d) Pads made from banana fiber
(e) Sea sponges used as sanitary material
(f) Pads made up of water hyacinth
(g) Menstrual cup
(h) Pads made from wool
(i) Reusable tampons

Biodegradable and Non-biodegradable: A comparison

There are several types of garbage, both biodegradable and non-biodegradable. As a result, waste categorization and correct disposal are important. There are two types of waste products: biodegradable and non-biodegradable. The dangers and concerns associated with trash disposal can be readily avoided by understanding the many sorts of waste. (2017 & www.ijirst.org, 2017

Types of biodegradable sanitary pads

Table 1: Difference between Biodegradable and Non-biodegradable.

Sr. No.	*Biodegradable*	*Non-Biodegradable*
1	Degradation process in Biodegradable waste is rapid	Degradation process in Non-Biodegradable waste is slow
2	Biodegradable waste is decomposed and degraded by microbes	Non-Biodegradable waste cannot be decomposed by microbes
3	Biodegradable waste are not accumulated but are used up in a short time	Non-Biodegradable waste often accumulate
4	Biodegradable waste become part of biogeochemical cycles and give back rapid turnover	Most of the Non-Biodegradable waste never enter into biogeochemical cycles, very slow and toxic
5	Biodegradable waste are used to produce energy manure, compost and biogas	Non-Biodegradable waste can be separated and recycled but t

Cellulose

Plants are formed primarily of cellulose, and plants constitute the major or initial link in the food chain (Which defines the feeding relationships of all living organisms). Cellulose is a very significant substance and the most prevalent naturally occurring biomaterials. (E.Woeller, 2015) The major ingredient of various natural fibres, such as cotton and higher plants, is cellulose. It is made up of lengthy chains of anhydro-D-glucopyranose un (PR, 2011) its (AGU), with three hydroxyl per AGU on each cellulose molecule. It is obtained as a pulp from fibrous materials such as wood or cotton, cow dung, and although it was used in pharmaceutical applications such as a filler in tablets, adsorbent in sanitary pads, it is microcrystalline cellulose that represents a novel and more useful cellulose powder, mainly used in the pharmaceutical industry as a diluent/binder in tablets. Cellulose is insoluble in water and most common solvents. (Nhlapo M, 2019).

Experimental

1. **Material procurement**

a) **Cow dung**

b) **Chemicals for extraction procedure:** Sulphuric acid, NaOH, Polylactic acid, EDTA, Na2S, calcium hydroxide, calcium hypochlorite, H2O2.

c) **Instruments:** Beaker, glass rod, measuring cylinder, magnetic stirrer, digester funnel, filter paper, weighing balance, Hot Air Oven, XRD, IR. **2.1 Raw material collection:** The fresh cow dung sample was collected. The sample was dried under sunlight to avoid fungal growth and kept in a hot air oven at 105 °C for 30 min to disinfect the sample. The dried sample was then powdered and sieved to coarse particle size.

2. **Extraction of cellulose from cow dung**

a) **Raw material collection:** The fresh cow dung sample was collected. The sample was dried under sunlight to avoid fungal growth and kept in a hot air oven at 105 °C for 30 min to disinfect the sample. The dried sample was then powdered and sieved to coarse particle size.

b) **Extraction, Bleaching and Optimization of cellulose from cow dung**

A total of 4 kg of dried and powdered cow dung was pre-hydrolyzed with 0.3% H2SO4 in a 15-L stainless steel digester rotating at 1 rpm and maintained at 120 °C for 30 min. The solid-to-liquid ratio was taken as 1:10 to ensure a homogenous mixture. After pre-hydrolysis, the pulp was filtered using a cloth filter and washed several times with distilled water to completely remove the acid residues. Subsequently, the pulp was dried in the hot air oven at 50°C. The percentage yield of the pre-hydrolyzed sample was calculated on dried weight basis. of pulp using the formula

% yield = weight of dried pre- hydrolyzed pulp sample/weight of dried cow dung sample * 100.

From the literature review it was clear that 1 kg of cow dung contains about 160- 200 gm. of cellulose.

❖ **The four different stages of bleaching involved are discussed below**

Hypochlorite bleaching— The cellulose pulp was agitated for 3 hours at 60 °C with a homogeneous combination of calcium hypochlorite (0.7 percent, w/v) and calcium hydroxide (0.3 percent, w/v). After that, the pulp was cloth filtered and rinsed with distilled water until all chemical residue was removed. The pulp was rinsed and dried in a hot air oven at 50 degrees Celsius.

EDTA bleaching— The prior bleached cellulose pulp was treated for 1 hour at 55°C with a **2** percent EDTA solution. The pulp was then filtered with a cloth, washed with distilled water, and dried in a hot air oven at 50 degrees Celsius.

Hydrogen peroxide bleaching—The EDTA-bleached cellulose pulp was treated with a 0.8 % of H2O2 for 1 h at 85 °C. Similarly, the bleached pulp was then filtered filtered by cloth, washed with distilled water, and dried in the hot air oven at 50 °C.

EDTA bleaching— Again the 2nd EDTA bleaching step was performed with 2% EDTA solution for 1 h at 55 °C. After bleaching, the pulp was cloth filtered, washed with distilled water, and dried in the hot air oven at 50 °C. The percentage yield of the extracted cellulose pulp was determined on a dried weight basis of pulp by using the equation.

The α-cellulose content was measured. Suitable amount of moisture-free cellulose pulp was weighed and dispersed in 17.5% NaOH for 30 min at 25 ± 0.2 °C. After that equivalent amount of distilled water was added into the sample and stirred for another 30 min at 25 ± 0.2 °C. After a total interval of 1 h, pulp was filtered and washed with dilute alkali and water and was further oven dried at 50 °C. The % yield of α-cellulose was calculated on a dry weight basis.

Calculated on dried weight basis of pulp using the formula

% yield = weight of dried pre hydrolysed pulp sample/weight of dried cow dung sample * 100.

RESULTS AND DISCUSSION

1. **Optimization of the cellulose**

The optimisation of KP was performed in a stepwise manner for their pulp production efficiency in terms of percent yield of cellulose and colour of pulp is given in table below. 15 % NaOH and 10% Na2s 160 °C for 60 minutes was determined to be the best conditions for the KP procedure. The percent yield, colour of cellulose pulp, temperature, and time required in the KP of cow dung biomass were optimised to achieve good yield with the least amount of chemical treatment, temperature, and time. The optimisation of KP for pulp production efficiency in terms of percent yield of cellulose and pulp colour was done in a progressive way.

Table 2: Optimization of the different sample code of cellulose.

Sample code	NaOH (%)	Na2S (%)	Temp.(c)	Time (mint.)	%Yield of cellulose	Colour of cellulose
C1	10	5	60	30	10.2%	Light Brown
C2	15	5	80	30	17.5%	Light Brown
C3	20	10	100	30	9.2%	Light Brown
C4	15	15	120	30	12.9%	White
C5	15	10	160	30	11.8%	White
C6	15	10	160	60	18.1%	White

2. Characterisation of cellulose

a. Powder X-ray diffraction analysis: Cellulose pulp was first prepared from cow dung by cooking with mixture of NaOH and Na2S solution at 100^{0}C for 30 minutes. Bleached kraft cellulose pulp was prepared by subsequent treatment of using acid sodium chlorite solution 120^{0}c at room temperature for 30 mint.the white pulp obtained samples were front-loaded into shallow (ca. 0.5 mm) wells machined into zero background holders manufactured from off-axis single crystal quartz. XRD patterns were collected using a PANalytical Aeries Symandzu X-RAY DIFFRACTOMETER with Cu Kα radiation.

b. Fourier transform infrared spectroscopic analysis: The fourier transform infrared (FT-IR) Spectra of the cow dung sample were recorded using Shimadzu IR Prestige 21 in the wave number range of 4000-400cm-1. total 5 mg of oven dried cellulose was taken and mix them with Kbr salt in the ration 1:3.the IR spectra recorded with 20 scans.

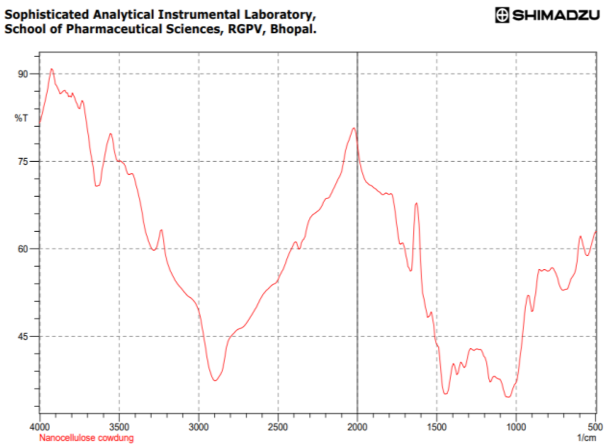
c) X-Ray diffractometer: Cellulose exists in both amorphous and crystalline forms. Powder X-ray diffraction (XRD) analysis was Performs in PAN analytical X –Ray instrument indicates the amount of crystalline form of cellulose. The crystallinity index of the both α-cellulose was found to be 47.58% and 53.30%. The XRD data has shown a significant increase in the crystallinity of cellulose after the acidic hydrolysis which is mainly due to removal of amorphous regions under acidic conditions.

Graph 1: X-ray diffraction (XRD) of cellulose.

d) Infra-Red Spectroscopy

The fourier transform infrared (FT-IR) spectra of the cow dung sample and extracted cellulose pulp sample were recorded using a Shimadzu in the wave number range of 4000–400 cm−1. A total of 5 mg of oven-dried cellulose and cow dung samples were used to record IR spectra. The absorption at the Wave numbers 3332 cm−1 and 3375 cm−1 is due to stretching vibrations of O-H groups and at 2895 cm−1 and 2860 cm−1 due to symmetric C-H stretching vibrations in both the samples. The peak at 2918 cm−1 is due to asymmetric stretching vibrations in the cow dung sample. Thus, the presence of cellulose in the sample was characterised by the presence of relevant peaks in the IR spectrum.

Interpretation of IR spectrum



Graph 2: IR Spectrum of cellulose.

Table 3: IR Bands.

Sr. No.	Band	Absorption
1	2337	CO2
2	1639 and 1635	Bending of absorbed water
3	1321	C-O and C-C vibrations
4	1157	C-O anti-symmetric bridge stretching
5	1076-1022	C-O-C pyranose ring skelton
6	896	Glycosidic linkage

3. Water absorbency capacity of cellulose

This method determines the total absorption capacity of the material. A compressed cellulose sample is laid on a flat level. Water is to be dripped by the help of dropper at the rate of 2 -5 ml per minute. After that consume of water ml/mint is noted. The tests results showed that the cellulose sheet adsorbed 8-10 ml of water.

Table 4: Different water absorbency capacity of cellulose.

Sr. No.	Water (ml/min)	Time required for absorption of water
1	2	15 seconds
2	4	20 seconds
3	6	30 seconds
4	8	45 seconds
5	10	1.30 min

4. Development of adsorbent material from extracted cellulose

100 gm of Cellulose were weighted and compressed with the help of manual compressor. This is the super adsorbent layer which is second layer is in sanitary napkin has thickness 1 to 2 mm.

5. Testing absorbance capacity of cellulose

Absorption is characterized by the rate of uptake as well as the volume of liquid that the material can hold, and it is influenced by material qualities as well as organizational structure. The absorptive ability of a substance can be influenced by its relative composition and orientation. A compressed cellulose sample is set on a flat level in this procedure to assess the material's total absorption capacity. Water should be dripped at a rate of 2-5 ml per minute using a dropper. Following that, the amount of water consumed in milliliters per minute is recorded.

6. Designing of biodegradable sanitary pad

Selection of raw materials with the aim of replacing them in different layers of Sanitary Napkins. Our materials have similar characteristics as present in commercially available sanitary napkin with Eco-friendly and biodegradable characterizes.

The layers of bio-degradable napkin are

- First layer – Bio-degradable polymer (Poly lactic acid)
- Second layer- Super absorbent material (Cellulose)
- Third layer- Natural fibres and cotton
- Fourth layer- Bio-degradable polymer (Poly lactic acid)

CONCLUSION

The current study concluded that cow dung can act as an idea feedstock for the extraction of cellulose. Cow dung biomass has been utilised for the extraction of cellulose and preparation of nanocellulose. The extraction of cellulose was carried out using the optimised kraft pulping process with minimal possible chemical load. Although cellulose was isolated in moderate yield as compared to the plant biomass, it can be considered good feedstock for the development of several value-added products. Also, α-NC prepared from the extracted cellulose was found to have excellent surface charge which imparts good particle stability in dispersions This alternative way of animal waste utilisation serves dual function; it helps in management of huge amount of animal waste and also helps in the development of useful biomaterials like sanitary napkin, thus represents a good example of "**Waste to Wealth.**

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