The Pharma Innovation Journal 2019; 8(9): 414-417

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2019; 8(9): 414-417

www.thepharmajournal.com
Received: 10-07-2019
Accepted: 12-08-2019

Saroj Devi
Department of Fabric & Apparel Science, Institute of Home Economics, University of Delhi, New Delhi, India

Charu Gupta
Department of Fabric & Apparel Science, Institute of Home Economics, University of Delhi, New Delhi, India

MS Parmar
NITRA, Ministry of Textiles, Govt. of India. New Delhi, India

Shankar Lal Jat
ICAR-Indian Institute of Maize Research, IARI, Pusa Campus, New Delhi, India

Needhi Sisodia
NITRA, Ministry of Textiles, Govt. of India. New Delhi, India

Neha Kapil
NITRA, Ministry of Textiles, Govt. of India. New Delhi, India

Correspondence
Saroj Devi
Department of Fabric & Apparel Science, Institute of Home Economics, University of Delhi, New Delhi, India

Impact analysis of chemicals on properties of corn stalk fibre during different process

Saroj Devi, Charu Gupta, MS Parmar, Shankar Lal Jat, Needhi Sisodia and Neha Kapil

Abstract
Agricultural residues are the biomass left in the field after harvesting of the economic components i.e., grain. Large quantities of crop residues are generated every year, in the form of cereal straws, woody stalks, and sugarcane leaves/tops during harvest periods. These residues are used as animal feed, thatching for rural homes, residential cooking fuel and industrial fuel. However, a large portion of the crop residues is not utilized and left in the fields. The disposal of such a large amount of crop residues is a major challenge for sustainability of Indian agriculture. To utilize the increased biomass of corn efficiently and to avoid problems like residue burning its textile application can be explored for making ecologically sustainable agriculture. Extraction of fibre was done by optimizing parameters. Impact of different alkali concentration, scouring and bleaching on the fibre was analyzed. Different properties like bundle strength, elongation%, and weight (gm) were analyzed. From the results it has found that chemical slightly impact the strength, elongation and weight of the fibre. Though, Fibre was suitable for textile applications.

Keywords: Bundle strength, elongation %, hydrogen peroxide**,** scouring, weight

1. Introduction

Crop Biomass burning is a global phenomenon and this burning may emit significant quantity of air pollutants like CO_2, N_2O, CH4, CO, NH_3, NO_x, and SO_2, which contributed to poor air quality worldwide. India produces about 500 million tons of crop residues annually. These residues are used as animal feed, composting, thatching for rural homes and fuel for domestic and industrial use. However, a large portion of the residues, about 140 Mt, is burned in field primarily to clear the field from straw and stubble after the harvest of the preceding crop (MNRE, 2012) [1]. Burning of crop residue is environmentally unsafe as it leads to release of soot particles and smoke causing human health problems and emission of greenhouse gases adding to global warming and climate change. It also results in loss of plant nutrients such as N, P, K, S and carbon, which are so important for soil health.

Yilmaz (2013) studied fibres extraction from corn husks by alkalisation at concentration varying from 2.5 g/l to 10g/l NaOH for different duration between 30 minutes and 120 minutes at boiling temperatures. The highest tensile performance was obtained in 5-10 g/l NaOH concentration and 60-90 minutes duration ranges. She reported a decrease in moisture content with increasing alkali concentration and duration.

In another study conducted by Yilmaz (2012) corn husks fibres were extracted from by water retting and alkalization processes followed by enzymatic treatments. She reported that enzymatic treatments result in increase in initial moduli and breaking tenacity for alkalized fibres, while resulting in loss of breaking tenacity and elongation in water retted fibres no significant effect of enzymatic treatment duration was obtained on the mechanical properties of corn husks fibres. Alkalised fibres had higher elongation and lower stiffness values compare to water retted ones but higher than the other conventional fibres.

The diameter, length, tensile strength, and modulus of the wheat straw fibers are some important Physical and mechanical properties of fibers.The Student's *t*-test showed that the average length and diameter of microbially retted fibers are significantly lower ($P<0.01$) than that of the mechanically processed fibers. About 83% of wheat straw fibers processed by mechanical refining had lengths in the range of 0.5–2.5mm with an average length of 1.87mm and 87% of the fibers obtained by microbial process had lengths in the range of 0.5–2.5mm with an average of 1.49 mm. The tensile strength of microbially retted fibers is significantly higher than the mechanically processed fibers ($P<0.01$), whereas the difference between the modulus of the fibers prepared by the two processes is not significant (*P*>0.05). The higher fiber strength of the microbially retted wheat strawfibers than the mechanically processed fibers may be caused by the reduction in the number of structural flaws or weak points associated with the retted fibers. This, in turn, can be due to the partial removal of hemicelluloses and surface impurities during the retting process that provides a more uniform and homogenous structure to the retted fibers. The large standard deviation in the strength and modulus of the wheat straw fibers indicates the large variation in the strength properties of the fibers and is expected for natural fibers. Similar results were reported earlier by Hornsby *et al*. (1997).

2. Materials and methods

2.1 Sourcing material

Agriculture biowaste was collected from ready to harvest cornfield of Indian Institute of Corn Research (IIMR) and Indian agricultural research Institute (IARI) Delhi. Chemicals were taken from laboratory of NITRA, Ghaziabad, Uttar Pradesh.

2.2 Methods

Under this study, the raw material was treated with alkalis for partial delignification. The delignification process using alkali was standardized by changing one parameter and keeping other constant. The important parameters like concentration of alkali, the temperature of the process, duration of treatment, material to liquor ratio (MLR) were which standardized. To remove the natural colour of the extracted fibre, it was treated with bleaching agent like hydrogen peroxide, after bleaching the fibres were washed and dried at ambient conditions. UV-Visible Spectrophotometer was used to determine the whiteness index of the fibres. The physic-chemical properties like bundle strength, elongation at break, whiteness index were evaluated in NITRA.

3. Result and discussions

3.1. Impact of alkali concentration on properties of corn stalk fibre during different stage of fibre process

During different stage of processing of corn stalk fibre like extraction process, scouring and bleaching of fibre, impact of chemical on fibre was studied. Different mechanical properties i.e. bundle strength, elongation at break, and weight of the fibre were analyzed to optimize the extraction process. From the table 1 it can be concluded that bundle strength of fibre is decreasing as the NaOH% is increasing as 3% NaOH treated corn stalk fibre have 21.11 denier and 7% have 16.11 denier of bundle strength. Scouring and bleaching also impact the bundle strength of the fibre as the concentration of H_2O_2 increasing, strength of the fibre is decreasing. Strength of the fibre decreases because chemical concentration opens the fibre structure and removes the lignin component of the fibre. Elongation at break% was also impacted by the chemical concentration during different stages of the fiber processing. From extraction of fibre to the bleaching of the fibre noticed that as% of chemical concentration increasing its effects the elongation of the fibre. As at time of souring with 3% of NaOH concentration elongation was highest, as concentration increases elongation decreasing. Similar tendency was seen at the time of scouring and bleaching of the corn stalk fibre. Every stage of processing opens the fibre and remove the extra non cellulosic material. Similar study was conducted on corn husk fibre by Archna *et al.* (2017) [3] stated that concentration of NaOH impacts the fiber's bundle strength and fineness. As concentration of NaOH and temperature parameters is increasing, bundle strength of fibre decreasing. Analysis of impact on Weight% (yield) of the fibre was also studies as shown in Table 1 and figure no.1. As NaOH concentration is increases weight of the extracted fibre decreases.

Table 1: Impact of alkali concentration on properties of corn stalk fibre during different stage of fibre process

Corn stalk fibre	Bundle strength (Denier)			Elongation (%)			Weight (gm)		
	3%	5%	7%	3%	5%	7%	3%	5%	7%
Extracted fibre sample	21.11	19.88	16.11	4.2	4.3	5.1	3.12±0.02	2.97±0.19	2.93±0.03
Scoured sample	20.77	16.09	12.09	4.5	5.0	5.3	3.01±0.12	2.92±0.21	2.87±0.11
Bleached sample	17.26	12.18	10.12	5.4	5.7	5.9	2.98±0.07	2.83±0.08	2.77±0.14

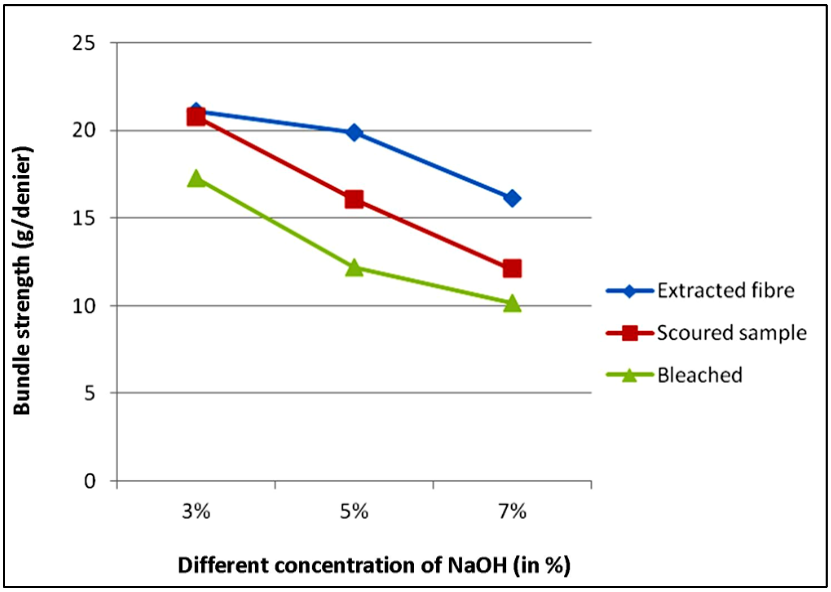

Fig 1: Impact on fiber's Bundle strength of chemical concentration during different stage of fibre processing

Fig 2: Elongation and bundle strength testing machine

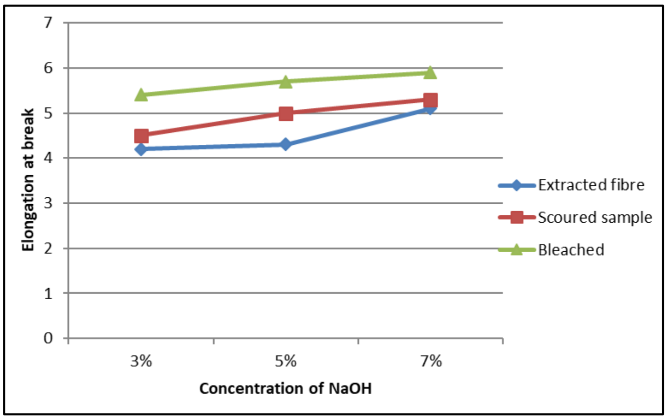

Fig 3: Impact on fiber's elongation at break of chemical concentration during different stage of fibre processing

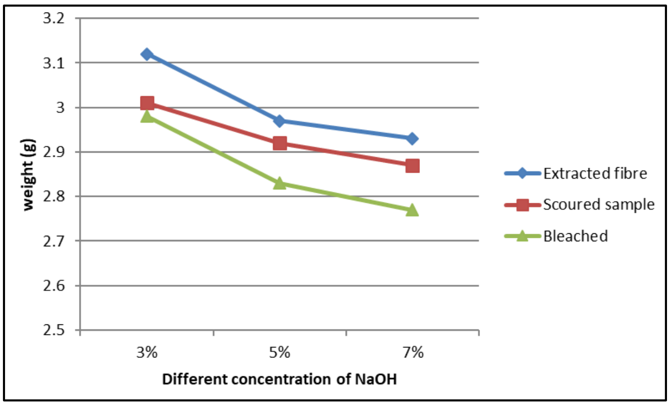

Fig 4: Impact on fiber's weight of chemical concentration during different stage of fibre processing

3.2 Optimization of Bleaching Formulation for Fibres

To remove the natural colour of the extracted fibre, it was treated with bleaching agent like hydrogen peroxide to impart whiteness to the fibre. After bleaching the fibres were washed and dried at ambient conditions. UV-Visible Spectrophotometer was used to determine whiteness index of the fibres. As the optimum pH and temperature is already established for this bleach only concentration of bleach and treatment time were optimized. Under this hydrogen peroxide agent was selected for further study on the basis of whiteness index and strength of the fibre.

Table 2: Effect of concentration of hydrogen peroxide and time

Parameters	Effect of concentration of hydrogen peroxide and time
Temperature	85 ^{0}C -90 ^{0}C
Time (minutes)	30, 60, 90
pH	10.5
MLR	1:30
Concentration of hydrogen peroxide (30%)	3g/l, 5g/l, 7g/l, 9g/l

3.3 Effect of concentration of hydrogen peroxide and treatment time:

To remove the natural colour of the extracted fibre, it was treated with bleaching agent like hydrogen peroxide to impart whiteness to the fibre. To obtain the high quality fibre the bleaching concentration was optimized for corn stalk fibre, first of all raw material was treated with different concentration of H_2O_2 3g/l, 5g/l 7g/l and 9g/l NaOH concentration. The other parameters temperature 85-90 ^oC was maintained for 30, 60, 90 minutes at 10.5pH level and 1:30 MLR as shown in Table 2. UV-Visible Spectrophotometer was used to determine whiteness index of the fibres. Table shows the bundle strength, elongations at break and whiteness index of bleached fibres. It is obvious from the results depicted in the table that the fibres did not bleach to white as the whiteness index is only 78, even for the most vigorous treatment i.e. 9 g/l hydrogen peroxide for 90 minutes. In spite of bleaching the fibres with such higher concentration of hydrogen peroxide, the fibres did not leave their inherent yellowish tinge. Interestingly, Reddy and Yang (2007) have reported to obtain whiteness index of 98 by bleaching cornhusk fibres with 3 g/l hydrogen peroxide at 90 ^{0}C for 60 minutes. In another study Salam *et al* (2007) have claimed to bleach cornhusk fibres to a CIE whiteness index of 74 after giving a delignification pre-treatment with sodium sulphite. Similar study was also conducted by Archna *et al*. on corn husk fibre with hydrogen peroxide bleach and found that corn fibre have naturally yellow colour. After bleaching it has 72 whiteness indexes at 90 ^{0}C temperatures for 90 minutes.

Table 2: Effect of concentration of hydrogen peroxide and treatment time on cornstalk fibres

Time (Minutes)	Concentration of hydrogen peroxide											
	3g/l			5g/l			7g/l			9g/l		
	Bundle strength (g/denier)	Fineness (Denier)	W. I	Bundle strength (g/denier)	Fineness (Denier)	W. I	Bundle strength (g/denier)	Fineness (Denier)	W. I	Bundle strength (g/denier)	Fineness (Denier)	W.I
30	6.44	95	49	5.4	90	55	4.2	82	59	3.02	71	61
60	5.33	92	51	5.33	86	60	4	78	67	2.88	67	69
90	5.1	87	54	5.14	83	63	3.89	74	69	2.7	62	70

Fig 5: Corn stalk fibre a) Extracted, b) Scoured, c) Bleached

As the optimum pH and temperature is already established for this bleach only concentration of bleach and treatment time were optimized. Under this study 7g/l of hydrogen peroxide agent for 30 minutes was selected for further study on the basis of whiteness index and strength of the fibre. The bundle strength of fibres reduced considerably with increase in concentration of hydrogen peroxide and treatment time. Similar study was conducted by archna *et al*, (2018) summarized that Up to 2 g/l concentration of hydrogen peroxide, not much lowering of strength had occurred but at higher concentration the loss in strength was quite high. Considering all the three parameters, concentration of 2 g/l hydrogen peroxide for 60 minutes treatment time was selected, as the fibres had optimum properties at this combination. The softener, DPT 080 (Resil) was applied to the corn stalk fibres after bleaching, at the concentration of 2% owf as per the specifications mentioned by the supplier. The application of softener resulted in smooth handle and it also made the opening of fibres much easier.

4. Conclusion

- It was found that optimum concentration of NaOH for fibre extraction was 5g/l. with temperature, process time duration and MLR were 100 ^{o}C, 60 minutes and 1:50 respectively. With this optimized condition the average weight of fibre was 2.28 g from the 5g sample weight of corn stalk.
- Bundle strength of fibre decreased as the alkali concentration increased as 3% NaOH treated corn stalk fibre had 21.11 denier while 7% NaOH had 16.11 denier of bundle strength.
- Scouring and bleaching also impacted the bundle strength of the fibre as the concentration of H_2O_2 increased, strength of the fibre decreased.
- Elongation at break was also impacted by the chemical concentration during different stages of the fiber processing and it was found that with increased chemical concentration increased the elongation of the fibre.
- As at time of souring with 3% of NaOH concentration elongation was highest, as concentration increases elongation decreasing. Similar tendency was seen at the time of scouring and bleaching of the corn stalk fibre.
- Every stage of processing opens the fibre and remove the extra non cellulosic material. As concentration of NaOH and temperature parameters is increasing, bundle strength of fibre decreasing.
- Fibers did not bleach to white as the whiteness index is only 78, even for the most vigorous treatment i.e. 9 g/l hydrogen peroxide for 90 minutes. In spite of bleaching the fibres with such higher concentration of hydrogen peroxide, the fibres did not leave their inherent yellowish tinge.
- The bundle strength of fibres reduced considerably with increase in concentration of hydrogen peroxide and treatment time.

5. References

1. http:/www.fibre2fashion.com, Ministry of New and Renewable Energy MNRE, 2012.
2. Holbery J, Houston D. Natural-fiber-reinforced polymer composites in automotive applications. JOM, 2006; 58(11):80-86.
3. Archna *et al*. Extraction of Cornhusk Fibres for Textile Usages, Journal of Polymer and Textile Engineering. 2017; 4(1):29-34