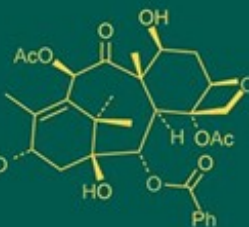
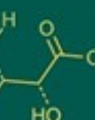
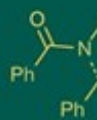
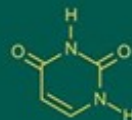
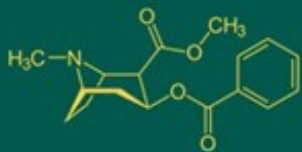


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
Indexing: Embase
IJABR 2026; SP-10(10): 651-655
www.biochemjournal.com
Received: 15-08-2026
Accepted: 26-09-2026
Published: 08-10-2026

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Optimization of parameters for surface modification of sodium hydroxide treated *Sansevieria trifasciata* cellulosic fibres

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DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i10Sh.10357>

ABSTRACT

The aim of this study is to optimize the alkali treatments to improve the physical, mechanical and surface properties of water-retted *Sansevieria trifasciata* cellulosic fibres for sustainable material applications. The experimental approach involved studying the effects of processing parameters on fibre properties and characteristics. The alkali treatment was carried out using sodium hydroxide (NaOH) at concentrations of 2.5, 5.0 and 7.5 g/L, liquor ratios of 1:10 to 1:30, temperatures of 80 °C to 100 °C and treatment times of 60-120 minutes with the pH values ranging from 6-8. The fibre samples (10 g) were soaked with distilled water and treated at a required temperature. The treated samples were neutralized with 10% acetic acid, washed and oven-dried to a constant weight. The comparative studies of the two treatments demonstrate the impact of controlling process parameters to enhance fibre surface roughness, bonding interface, tensile strength and durability. The findings show that surface modification parameters improve compatibility of *S. trifasciata* fibres with matrix materials and composites, resulting in better performance and durability. This research suggests that these conditioned fibres could be used as sustainable alternatives to synthetic reinforcement in different industries. The potential applications include composites, green textiles, geo-textiles, packaging products, automotive interiors, construction and insulation materials, paper and pulp products and reinforcement of bio-based plastics. This research supports the development of materials through the use of plant-based renewable fibre resources and process optimization to deliver enhanced properties that facilitate industrial-scale production.

Keywords: *Sansevieria trifasciata*, Natural fibres, Alkali treatment, Surface modification Sustainable materials

1. Introduction

Cellulosic fibres are categorized into six types: bast, leaf, seed, straw, grass and wood. These fibres can appear in forms, such, as hairs (cotton, kapok) hard fibres (coir, sisal) and fibre sheaves (flax, hemp jute). The plant fibres are classified on their utility such as primary and secondary. Plants to be used as fibres for primary utilities include hemp, jute, kenaf etc. while the byproducts of plants such as coir, pineapple, etc. belong to the secondary group (Faruk *et al.*, 2012). The production of plant fibres primarily depend on geographical location and the quantity of fibre production vary every year due to many reasons such as weather conditions, type of soil, temperature and location.

Geometrical dimensions of plant fibres, especially the length depend mainly on location of fibres in the plant. Fruits and seed fibres have short fibres (few cm) whereas stem and leaf fibres have long fibres (Smole *et al.*, 2013). Another industrial definition that a unit of matter has a length of at least 100 times its diameter, the structure is composed of long chain molecules preferred orientation, diameter around 10-200 microns (micrometers) and can be flexible (Landi 1998). All fibres are composed of molecules, which give it their special qualities and properties. The physical, mechanical and chemical properties of fibres are very diverse. The fashion and textile industries have adopted yarns and fabrics as the building blocks of today, with fibres as their basic components. Fibres are available in many forms, dependent upon origin and type and may be used in combination to suit the requirements of the product and the consumer.

Recent statistics revealed that while the annual world production of natural fibers has been about 45.5 million tons, production of these fibers in India has been almost 14.5 million tons. With the rise in consumption particularly in the developing countries, the demand for natural resources for fiber production is likely to be surpassed by fibers' production along with inability to produce them on a scale proportional to its demand expected to make most of the existing fibers too costly or unavailable in commodity applications (Kanimozhi 2011). With the advancement of human life and awareness of the need for environmental protection, the demand for natural biodegradable, sustainable, non-toxic and eco-friendly fibres is increasing rapidly all over the world every day. The vegetable fibres of ramie, flax, hemp and other have been used as

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textile materials. But some plant yielding fibres species are still unexplored, these plant species can largely contribute to economic upliftment of local people through development of Research and Development programmes suitable for small scale industrialization.

The natural fibres offer several advantages over synthetic fibres, such as low weight, low density, low cost, acceptable special properties and the fact that they are both recyclable and biodegradable. They are also renewable and possess a good strength to stiffness ratio. With the world market moving towards eco-friendly, biodegradable and recyclable textiles, natural fibre is in the spotlight. But there are plants all over the earth that could potentially be used for valuable fibres, but have never been studied. Plants with longer leaves seem to have greater fibre generating capacity (Kant and Alagh 2015). Natural fibres like banana, cotton, coir, sisal and jute have interesting applications in consumer goods, cost effective housing materials as well as other civil structures by interest of scientists and technologists. They have been found to possess better electrical resistance, thermal and acoustic insulation properties and fracture resistance properties, which are natural fibre composites.

2. Material and methods

2.1 Optimization of different parameters for alkali treatment of STF fibres

Extraction process using alkali (sodium hydroxide) *S. trifasciata* (STF) fibres used for optimization of different parameters i.e. chemical concentration, material to liquor ratio (MLR), temperature, time and pH.

2.2 Optimization of alkali concentration

In order to get the optimum concentration, three different concentration of Sodium hydroxide i.e. 2.5, 5.0 and 7.5 g/L were taken. During treating the STF fibres, other factors such as material to liquor ratio, temperature, time and pH were kept constant. M:L ratio was kept at 1:20. After treatment, the treatment was removed and cold water was used to wash the effect of treatment effect. Alkali treated samples were dried and concentration of alkali was optimized.

2.3 Optimization of material to liquor ratio

To calculate the optimum material to liquor ratio, three different ratios i.e. 1:10, 1:20 and 1:30 were taken. During the treatment of STF fibres, other parameters such as concentration, temperature, time and pH were kept constant. The optimum concentration of alkali was considered as 5.0 g/L. The samples were withdrawn and then given cold water wash in order to bring back the pH to normal. The samples treated with alkali were dried and material to liquor ratio was optimized.

3. Optimization of treatment temperature

Three different temperatures 80°C, 90°C and 100°C were considered. While treating STF constant, other factors i.e. concentration, material to liquor ratio, time and pH were constant. The concentration of alkali and material to liquor ratio were kept as 5.0 g/L and 1:20, respectively. The samples removed from the treatment were washed with cold water rinsed to reverse the treatment. Alkali treated samples were dried and temperature was optimized.

3.1 Optimization of treatment time

Three different time durations i.e. 60, 90 and 120 minutes periods were used. While treating the STF fibres, other variables i.e. concentration, material to liquor ratio, temperature and pH were kept constant. The optimum concentration of alkali, material to liquor ratio and temperature were taken 5.0 g/L, 1:20 and 90°C, respectively. Following the treatment, the samples were removed and rinsed with cold water to remove the effect of treatment. Alkali treated samples were dried and time was optimized.

3.2 Optimization of treatment pH

To optimize treatment pH, the treatment solutions with different pH (6, 7 and 8) were prepared. During the treatment of STF fibres, the other parameters i.e. concentration, material to liquor ratio, time and were kept constant. The optimum alkali concentration and material to liquor ratio was taken 5.0 g/L, 1:20, 90°C and 90 minutes, respectively. The samples were washed with removed and washed with cold water to remove the effect of the treatment. Sodium hydroxide treated samples were dried and pH was adjusted.

4. Results and discussion

The effect of alkali treatment on fibre properties, different conditions were optimized for the following parameters for water retted STF fibres i.e. chemical concentration, material to liquor ratio, treatment temperature, time and pH. Various alkali treatment conditions were optimized based on improvement in fibre yield, fibre fineness, fibre bundle strength, elongation, moisture content and moisture regain. Treatment with alkali was done under the following conditions presented in tables 1-5.

4.1 The effect of alkali concentration on fibre properties of water retted STF fibres

Three concentrations of alkali (2.5, 5.0 and 7.5 g/L) were determined and optimized on the basis of fibre properties which are improvement in fibre yield, fibre fineness, fibre bundle strength, fibre elongation, fibre moisture content and fibre moisture regain. The results on fibre yield and fineness as per table 1 showed that at 2.5 g/L concentration of chemical, the yield was found to be 0.88 ± 0.025 per cent while the fineness was found to be 2.53 ± 0.04 mm. The fibre yield fell from 0.84 ± 0.038 per cent to 0.77 ± 0.090 per cent as the concentration of sodium hydroxide rose from 5.0 to 7.5 g/L. Regarding fibre fineness, the fibre fineness value of 44.38 ± 14.90 denier was recorded at a sodium concentration of 5.0 g/L when compared with other concentrations of 2.5 and 7.5 g/L. Likewise as the concentration increased the fibre fineness rose from 44.38 ± 14.90 denier to 53.56 ± 8.52 denier at 7.5 g/L. As can be seen from the table, as the alkali concentration is increased there is also an increase in softness and quality of fibre but at the same time an increase in the bundle strength. At 2.5 g/L of NaOH concentration, the bundle strength was found to be 41.94 ± 3.02 g/tex whereas at 5.0 g/L of concentration it was noticed that the bundle strength was 41.18 ± 4.19 g/tex, respectively. The bundle strength was lowest i.e. 39.11 ± 3.72 g/tex at 7.5 g/L concentration. From the table 1, it was found the concentration at 2.5 g/L, the elongation at break was discerned 5.25 ± 0.480 per cent whereas the elongation was decreased at 5.0 g/L i.e. 5.01 ± 0.195 per cent. The elongation at break was determined at 7.5 g/L as 4.10 ± 0.327 per cent. At 2.5 g/L of NaOH solution, the moisture content and moisture regain was found to be 0.01 ± 0.007 and 0.02 ± 0.005 per cent, respectively. The moisture content was recorded as increasing from 0.02 ± 0.007 per cent to 0.02 ± 0.006 per cent with an increase in the concentration of alkali from 5.0 to 7.5 g/L respectively. At 5.0 to 7.5 g/L, the moisture regain was noticed as 0.02 ± 0.008 per cent and 0.02 ± 0.005 per cent. The results indicate that the concentration of 5.0 g/L was more appropriate to treat the STF fibres. Thus 5 g/L of chemical concentration was selected as the optimum concentration for treatment of water retted STF fibres with fibre yield 0.84 ± 0.03 per cent, fineness 44.38 ± 14.90 denier, bundle strength 41.18 ± 4.19 g/tex, elongation 5.01 ± 0.19 per cent, moisture content 0.025 ± 0.007 per cent and moisture regain 0.026 ± 0.008 per cent, respectively.

4.2 The effect of material to liquor ratio on fibre properties of water retted STF fibres

The study of simultaneous optimization of treatment concentration and effect of material to liquor on water retted STF fibres was conducted. Now, the chemical concentration was fixed as 5.0 g/L of NaOH and three different (owf) (1:10, 1:20 and 1:30 MLR) material to liquor ratio were selected and optimized for their textile properties, such as improvement in fibre yield, fineness, bundle strength, elonga

tion, moisture content and regain as presented in Table 2. The fibre yield in the above experiment had been identified as 0.83 ± 0.018 per cent at 1:10 material to liquor ratio and 45.25 ± 9.94 denier fibre fineness. As the material to liquor increased from 1:20 to 1:30, the fibre yield decreased from 0.82 ± 0.013 and 0.70 ± 0.012 per cent. At 1:20, the fibre fineness was found to be 45.99 ± 3.31 denier and at 7.5 g/L stagnation was witnessed, the fibre fineness was 39.99 ± 3.81 decreased. Bundle strength and elongation of the STF fibres treated with NaOH with 1:10 material to liquor ratio were presented in table 2, which shows that the bundle strength and elongation at break of the treated fibres were 44.14 ± 1.26 g/tex and 5.50 ± 0.47 per cent respectively. When material to liquor ratio increased from 1:20 to 1:30, the bundle strength was found to be 42.72 ± 2.851 and 37.54 ± 1.513 g/tex, with 4.44 ± 0.42 and 3.93 ± 0.27 per cent elongation at break.

The moisture content of the material increased with the increase in material to liquor ratio from 1:10 to 1:20 (0.065 ± 0.007 per cent and 0.071 ± 0.010 per cent, respectively). The effect of material to liquor ratio on moisture content was observed at 1:30, was decreased. The moisture regain was found as 0.15 ± 0.196 per cent at 1:10 material to liquor ratio. As increasing material to liquor ratio from 1:20 to 1:30, the moisture regain was 0.07 ± 0.010 to 0.07 ± 0.018 per cent. Moisture regain was observed to have few changes in its bit. Then it was found that optimum ratio of 1:20 was used in the treatment of water retted STF fibres having fibre yield 0.82 ± 0.013 per cent, fineness 45.99 ± 3.31 denier, bundle strength 42.72 ± 2.851 g/tex, elongation 4.44 ± 0.42 per cent, moisture content 0.07 ± 0.010 per cent and moisture regain 0.07 ± 0.010 per cent.

Table 1. Effect of alkali concentration on fibre properties of water retted STF fibre

Concentration (g/L)	Fibre yield (%) Mean $\pm$ S.E.	Fineness (denier) Mean $\pm$ S.E.	Bundle strength (g/tex) Mean $\pm$ S.E.	Elongation (%) Mean $\pm$ S.E.	Moisture content (%) Mean $\pm$ S.E.	Moisture regain (%) Mean $\pm$ S.E.
2.5	0.88 ± 0.02	74.25 ± 6.55	41.94 ± 3.02	5.25 ± 0.48	0.01 ± 0.007	0.02 ± 0.005
5.0	0.84 ± 0.03	44.38 ± 14.90	41.18 ± 4.19	5.01 ± 0.19	0.02 ± 0.007	0.02 ± 0.008
7.5	0.77 ± 0.09	53.56 ± 8.52	39.11 ± 3.72	4.10 ± 0.32	0.02 ± 0.006	0.02 ± 0.005

*Mean, *Standard Error, += increase and -=decrease values

4.3 The effect of treatment temperature on fibre properties of water retted STF fibres

In this section the water retted fibres were treated with alkali treatment temperature and results are given in the Table 3. For optimization the treatment temperature, three temperatures i.e. 80°, 90° and

100° C were optimization was selected on the basis of their fibre properties i.e. improvement in fibre yield, fineness, bundle strength, elongation, moisture content and moisture regain.

Table 2. Effect of material to liquor ratio on fibre properties of water retted STF fibre

Material to liquor ratio (MLR)	Fibre yield (%) Mean $\pm$ S.E.	Fineness (denier) Mean $\pm$ S.E.	Bundle strength (g/tex) Mean $\pm$ S.E.	Elongation (%) Mean $\pm$ S.E.	Moisture content (%) Mean $\pm$ S.E.	Moisture regain (%) Mean $\pm$ S.E.
1:10	0.83 ± 0.018	45.25 ± 9.94	44.14 ± 1.263	5.50 ± 0.47	0.065 ± 0.007	0.15 ± 0.196
1:20	0.82 ± 0.013	45.99 ± 3.31	42.72 ± 2.851	4.44 ± 0.42	0.071 ± 0.010	0.07 ± 0.010
1:30	0.70 ± 0.012	39.99 ± 3.81	37.54 ± 1.513	3.93 ± 0.27	0.07 ± 0.008	0.07 ± 0.018

*Mean, *Standard Error, += increase and -=decrease values

It is visible from Table 3, that when the alkali treatment temperature was carried out for 80°C, the fibre yield was recorded to be 0.85 ± 0.45 per cent with 60.11 ± 6.23 denier fineness. The fibre yield was observed as 0.90 ± 0.05 per cent and fibre fineness was 45.73 ± 11.92 denier at increase the temperature from 90°C to 100°C, and 0.87 ± 0.04 per cent and fibre fineness 58.59 ± 7.51 denier respectively. The table elucidates that when alkali temperature was carried out at 80°C, the bundle strength was noticed as 41.75 ± 1.13 g/tex with 4.167 ± 0.36 per cent elongation at break. At 90°C, the bundle strength and elongation was found to be 43.48 ± 3.15 g/tex with 4.501 ± 0.60 per cent elongation at break. With continuous increase in temperature, the bundle strength was decreased 37.65 ± 0.72 g/tex with 3.68 ± 0.39 per cent elongation at break. The effect of temperature on

the moisture content and regain of fibres was 0.03 ± 0.014 and 0.02 ± 0.01 per cent respectively at 80°C. At 90°C of the temperature, the moisture content was recorded as 0.02 ± 0.007 per cent with 0.03 ± 0.01 per cent, respectively. The moisture content increased at a steady rate of 0.03 ± 0.009 per cent per unit of temperature and with the moisture regain of 0.10 ± 0.15 per cent per unit of temperature. Thus, the temperature of 90°C was chosen as the optimum temperature for the retting of water retted STF fibres with fibre yield (0.82 ± 0.013) per cent, fineness (45.99 ± 3.31) denier, bundle strength (42.72 ± 2.851) g/tex, elongation (4.44 ± 0.42) per cent, moisture content (0.07 ± 0.010) per cent and (0.03 ± 0.01) per cent moisture regain, respectively.

Table 3. Effect of treatment temperature on fibre properties of water retted STF fibre

Treatment temperature (°C)	Fibre yield (%) Mean $\pm$ S.E.	Fineness (denier) Mean $\pm$ S.E.	Bundle strength (g/tex) Mean $\pm$ S.E.	Elongation (%) Mean $\pm$ S.E.	Moisture content (%) Mean $\pm$ S.E.	Moisture regain (%) Mean $\pm$ S.E.
80	0.85 ± 0.45	60.11 ± 6.23	41.75 ± 1.13	4.16 ± 0.36	0.03 ± 0.014	0.02 ± 0.01
90	0.90 ± 0.05	45.73 ± 11.92	43.48 ± 3.15	4.501 ± 0.60	0.02 ± 0.007	0.03 ± 0.01
100	0.87 ± 0.04	58.59 ± 7.51	37.65 ± 0.72	3.68 ± 0.39	0.03 ± 0.009	0.10 ± 0.15

(continued on next page)

*Mean, *Standard Error, += increase and - = decrease values

4.4 The effect of treatment time on fibre properties of water retted STF fibres

The alkali treatment time was given for three different treatment time viz. 60, 90 and 120 minutes. The treatment time results of the alkali concentration are given in the Table 4. The fibre yield and fineness for the alkali treatment time 60 minutes was 0.85 ± 0.45 per cent and 59.25 ± 13.60 denier, respectively. At 90 minutes treatment time, the fibre yield was increased as 0.89 ± 0.04 per cent with decreased as 45.84 ± 9.20 denier fineness. With continuous increase in time at 120 minutes, the fibre yield was little bit increased to be 0.90 ± 0.05 per cent with 50.49 ± 9.11 denier fineness also increased. From Table 4, it is seen that the bundle strength of 45.092 ± 2.006 g/tex and elongation at break of 3.980 ± 0.273 per cent for 60 min of alkali treatment time. A longer treatment duration of alkali did not result in an increase

in bundle strength (g/tex) for all samples, as the bundle strength decreased from 43.66 ± 4.467 g/tex (elongation at break of 3.71 ± 0.258 per cent) at 90 minutes treatment time to 37.20 ± 3.097 g/tex (elongation at break of 3.715 ± 0.304 per cent) at 120 minutes treatment time. The alkali treatment time was carried out for 60 minutes, the moisture content was recorded as 0.035 ± 0.005 per cent with 0.036 ± 0.008 per cent moisture regain. The moisture content and regain was noticed to be 0.038 ± 0.009 to 0.035 ± 0.003 per cent and 0.04 ± 0.011 to 0.037 ± 0.005 per cent increasing treatment times from 90 to 120 minutes. Thus, it was concluded that 90 minutes was optimum time for extraction of fibre from water retted STF fibres with fibre yield 0.89 ± 0.04 per cent, fineness 45.84 ± 9.20 denier, bundle strength 43.66 ± 4.467 g/tex, elongation 3.71 ± 0.258 per cent, moisture content 0.038 ± 0.009 per cent and moisture regain 0.04 ± 0.011 per cent.

Table 4. Effect of treatment time on fibre properties of water retted STF fibre

Treatment time (minutes)	Fibre yield (%) Mean±S.E.	Fineness (denier) Mean±S.E.	Bundle strength (g/tex) Mean±S.E.	Elongation (%) Mean±S.E.	Moisture content (%) Mean±S.E.	Moisture regain (%) Mean±S.E.
60	0.85 ± 0.45	59.25 ± 13.60	45.09 ± 2.006	3.98 ± 0.273	0.035 ± 0.005	0.036 ± 0.008
90	0.89 ± 0.04	45.84 ± 9.20	43.66 ± 4.467	3.71 ± 0.258	0.038 ± 0.009	0.04 ± 0.011
120	0.90 ± 0.05	50.49 ± 9.11	37.20 ± 3.097	3.71 ± 0.304	0.035 ± 0.003	0.037 ± 0.005

*Mean, *Standard Error, += increase and - = decrease values

4.5 The effect of pH on fibre properties of water retted STF fibres

Three different pH ranges (i.e. 6, 7 and 8) were chosen for the optimization of treatment pH. The results of treatment pH are indicated in Table 5. The results of fibre yield and fineness treatment at pH at 6 is clearly shown in Table 5 that at this pH value, fibre yield was 0.82 ± 0.011 per cent and fibre fineness was 54.40 ± 17.416 denier. As there was an increase in the pH of the treatment bath from 7 to 8, there was considerable increase to decrease in fibre yield from 0.84 ± 0.022 per cent to 0.84 ± 0.022 per cent. The same fineness of fibre was observed to be 48.09 ± 2.715 and 45.55 ± 3.039 denier respectively at same pH. When the pH of the treatment bath was maintained at 6, the bundle strength was found to be 43.35 ± 1.577 g/tex with 4.65 ± 0.311 per cent elongation at break. As there was an increase in pH of the treatment bath from 7 to 8, the bundle strength was noticed

to be 40.77 ± 1.965 g/tex with 4.13 ± 0.208 per cent elongation at break to 36.38 ± 1.134 g/tex to 3.89 ± 0.397 per cent bundle strength and elongation. The moisture content at 6 pH bath recorded was 0.07 ± 0.006 per cent with moisture regain of 0.12 ± 0.145 per cent, respectively. When the pH of the treatment bath was maintained at 7 to 8, the moisture content was discerned 0.06 ± 0.012 to 0.15 ± 0.200 per cent with 0.074 ± 0.011 to 0.06 ± 0.008 per cent moisture regain. Hence the pH was optimized to be 7 for the formulation of bath and alkali treatment while considering following variables: change in fibre yield (0.84 ± 0.022 per cent), fibre fineness (48.09 ± 2.715 denier), bundle strength (40.77 ± 1.965 g/tex), moisture content (0.06 ± 0.012 per cent) and moisture regain (0.07 ± 0.011 per cent), elongation at break (4.13 ± 0.208 per cent). The water retted STF fibres were first immersed in the solution containing optimum concentrations of sodium hydroxide (5.0 g/L) in material to liquor ratio (1:20), at 90°C for 90 minutes and pH 7.

Table 5. Effect of treatment pH on fibre properties of water retted STF fibre

Treatment pH	Fibre yield (%) Mean±S.E.	Fineness (denier) Mean±S.E.	Bundle strength (g/tex) Mean±S.E.	Elongation (%) Mean±S.E.	Moisture content (%) Mean±S.E.	Moisture regain (%) Mean±S.E.
6	0.82 ± 0.011	54.40 ± 17.416	43.35 ± 1.577	4.65 ± 0.311	0.07 ± 0.006	0.1 ± 0.145
7	0.84 ± 0.022	48.09 ± 2.715	40.77 ± 1.965	4.13 ± 0.208	0.06 ± 0.012	0.07 ± 0.011
8	0.84 ± 0.022	45.55 ± 3.039	36.38 ± 1.134	3.89 ± 0.397	0.15 ± 0.200	0.06 ± 0.008

*Mean, *Standard Error, += increase and - = decrease value

5. Conclusion

The current research focuses on the potential of non-conventional plant resources as a potential source of natural, biodegradable fibres, particularly *Sansevieria trifasciata*. The use of *S. trifasciata* for fibre production helps in diversifying some of the fibre resources and decreases the dependency on traditional textile fibres. The fibres obtained from the leaves have features that make them appropriate for a variety of value-added applications, particularly in cases where biodegradability, renewability and environmental compatibility are important. The production of these fibres are potential uses in the

making of ropes, twines, paper, boards, mats, composites and a wide range of agro-textile products. When further processing and improvements to their performance are carried out, the fibres might also be put to use in certain textile and technical-textile products. Moreover, appropriate extraction, retting, chemical and enzymatic processing methods can enhance the fineness, strength, softness and general quality of the *S. trifasciata* fibres, which will increase their usefulness for a variety of applications. The conditions for fibre extraction and processing if consistent, fibre quality and commercial viability of fibres can be improved. Future research should concentrate on large-scale extraction, fibre-matrix compatibility, spinning and weaving be

haviour, dye ability, durability, biodegradation characteristics, life-cycle assessment and techno-economic feasibility.

6. Data availability

The data are included in figures and tables in the MS-Word format.

7. Conflict of interest

The authors declare that they have no conflicts of interest in the research, authorship and publication of this article.

8. Acknowledgement

Authors are grateful to Chaudhary Charan Singh Haryana Agricultural University (CCSHAU) for the research facilities. The authors not received any financial assistance for conducting research and publishing this article.

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How to cite this article: Kumari B, Rani L, Arya N. Optimization of parameters for surface modification of sodium hydroxide treated *Sansevieria trifasciata* cellulosic fibres. *International Journal of Advanced Biochemistry Research*. 2026;SP-10(10):651-655. doi: <https://www.doi.org/10.33545/26174693.2026.v10.i10Sh.10357>