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Empowering Livelihoods through Innovation: An Advanced Technology for Fibre Extraction of *Grewia Optiva*, J. R. Drumm. Ex. Burret

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ABSTRACT: The growing global interest in replacing synthetic fibres with natural alternatives is driven by the benefits of natural fibres, such as reduced skin irritation and environmental sustainability. In India, natural fibre production exceeds 400 million tons annually, with significant potential for rural economic development. The Himalayan region, endowed with abundant natural fibres like *Grewia optiva* (bhimal), offers an opportunity to enhance local livelihoods through the utilization of these resources. Traditionally, *G. optiva* twigs are harvested and subjected to 90-day retting process to extract fibres, which has adverse environmental impacts due to water pollution and emissions. This study presents a novel approach using a Modified Steam Explosion Treatment Machine (MSETM) developed and fabricated by Forest Research Institute, Dehradun, India to extract *G. optiva* saponins and fibre within a day, significantly reducing environmental impact and improving fibre quality. Various chemical and eco-friendly methods, including NaOH, ammonium oxalate, urea, thio-urea, and cow dung treatments, were explored to optimize the retting process. The NaOH treatment showed the most promising results in terms of fibre physico-chemical properties. Physico-chemical analysis revealed that alkali treatment improved fibre properties, making it suitable for high-value applications. The study demonstrates that advanced retting techniques can be enhanced the economic viability of *G. optiva* fibre production, supporting sustainable rural development and environmental conservation.

I. INTRODUCTION

Nowaday's natural fibres in replace of synthetic counter parts are gaining momentum all across the world. This is due to the fact that generally natural fibres do not cause skin irritation/diseases e.g., rashes, allergy, itching & other skin problems, which are often associated with the use of synthetic fibres. Rai and Jha, (2004) had reported that utilization of plants fibre for generating employments in rural area is cost effective and ecologically sustainable. The production of natural fibre in India is more than 400 million tons. In addition, natural fibres are ecofriendly and safe to the environment, and are biodegradable. The Himalayan region has been bestowed with an enormous fibre wealth, which has been used by the locals for their needs; the natural fibres can be exploited to improve the livelihood (Nitra, 2017). While in some cases cottage level production units are already operationalized, the potential of many other species needs to be fully explored. Most of the fibres produced from plants have very high strength, low elongation and good moisture absorption properties. Hence, they are used for making ropes, bags and other decorative items. As these fibres are extracted from stem (bark), their main disadvantages are thickness and harshness and improvement in extraction process and other mechanical processes can be improved the fineness and reduced the harshness, which can help them in production of value-added products such as fabrics for garments, home textiles and other technical textiles.

Grewia optiva (bhimal) is most suitable fodder tree and is found naturally on farmers lands (Bijalwan and Dobriyal, 2014). It is fast growing species and has a potential of survival even in harsh conditions in plains and foothills of Himalaya in Uttarakhand. The species is suitable for traditionally grown agroforestry species in the State of Uttarakhand. *G. optiva* is a vital source of natural fibre for rural economies. It is a valuable plant species that provides high-quality natural fibre for various applications, including the production of affordable articles such as ropes, mats, bags, footwear, carpets, and curtains etc. This fibre plays a crucial role in sustaining village economies. Traditionally, farmers harvest *G. optiva* twigs during the winter months when other fodder is scarce, using the leaves as livestock feed. The twigs are then bundled and submerged in a local water body (khall or gadhera) over 90 days (Kumar *et al.*, 2017). After retting, the fibre is extracted manually, washed, and Sun-dried.

Traditional retting leads to extensive pollution of water bodies. Environmental pollution is occurred due to methane and sulphide emission and water contamination are associated with conventional retting. It is a major concern that the

retting areas are almost devoid of higher aquatic life. Retting also leads to destruction of fisheries in these areas. In this traditional method, either fibre or shampoo can be collected. However, this conventional retting method has several limitations such as very longer retting duration, longer retting duration encourages over retting resulting less fibre recovery from top portion of the plants, the strength of over retting fibre may have very poor quality, because of lower fibre quality, farmers get low price for their fibre in the market, most of the fibre produced by this method is unsuitable for production of high valued diversified products, traditional retting process is not safe for aqua life and other dependents and young generation do not very keen to follow traditional fibre extraction system as it give unfavorable smell. Therefore, it has been noticed that there is larger scope to develop an advance method of fibre extraction from *G. optiva* and collection of saponins (shampoo) to improve their livelihood.

For the purpose a Modified Steam Explosion Treatment Machine (MSETM) has been developed and saponins and fibre were extracted within a day. In present investigation, extraction of saponins and fibre technology using MSETM have been developed and discussed here in detail by which youth may improve their livelihood without investment of extra labour and can earn instant cash. Besides above some chemicals and ecofriendly material were also tried to extract the fibre from *G. optiva*.

II. MATERIALS AND METHODS

Twigs samples for study of saponins and fibre extraction were collected from trees of *G. optiva* experimental sites at Animal Breeding Farm (ABF), Kalsi, Vikas Nagar, Dehradun, Uttarakhand, India (N 30° 31' 16.8", E 77° 50' 32.6"). Trees were 50% lopped and removed leaves from twigs. Twigs samples were taken and prepared as follows:

a) Determination of saponins

Saponins content was determined in various diameters of *G. optiva* twigs taken for study. Raw material was collected from selected trees randomly to determine the saponin content. The content of saponins was determined by following method of Nahapetian and Bassiri (1974).

A weighed amount of bark sample (3g) was heated with 100 ml aqueous ethanol (20% v/v) solution for 4 hrs. on water bath at 55 °C. The sample was than filtered and the filtrate was collected named A. The remaining residue was again heated with aqueous ethanol (20% v/v) for 4 hrs. on water bath and the sample was filtered to collect filtrate B.

Filtrate A+B were mixed and evaporated up to 40 ml over water bath at 90°C. The solution was than fractionated with diethyl ether using a separating funnel. The saponins were solubilized in aqueous layer which were further extracted using butanol. The process was repeated twice. The extracted saponins were washed with 5% of aqueous sodium chloride (NaCl) solution and then transferred into the evaporating dish. The saponin extract was dried in hot air oven overnight till it acquires a constant weight and the saponin yield was calculated as follows:

$$\text{Saponin \%} = \frac{W_2 - W_1}{\text{weight of sample}} \times 100$$

Where,

W_1 = Weight of evaporating dish

W_2 = Weight of evaporating dish + Sample taken

b) Development of improved retting process by various methods for extraction of *Grewia optiva* fibre

Various methods were tried to extract *G. optiva* fibre. Samples of *G. optiva* twigs were collected from selected site.

1. Mechanical Treatment

(i) Hot water treatment

G. optiva twigs were boiled for two to three hours in water. After removing the twigs from boiling water, fibre was manually extracted for further processes.

(ii) Water retting after crushing twigs and removal of saponins (shampoo)

G. optiva twigs were collected and crushed to collect the saponins (shampoo) and left for retting process in fresh water for 90 days to obtain fibre from twig.

(iii) Use of perforated pot

G. optiva twigs were collected and put into perforated pot with water to soften the bark. Pot was kept on heating object for 5 hours. Twigs were removed after these got soften and bark was removed manually. The obtained bark was boiled for 1 hour with caustic soda, washed manually and dried in Sun to obtain fibre.

2. Use of Modified Steam explosion treatment machines (MSETM), extraction of saponins (shampoo) and fibre (Abraham *et al.*, 2013)

A modified steam explosion treatment machines (MSETM) has been fabricated by Principal Investigator of the project entitled “Livelihood improvement through sustainable utilization of *Grewia optiva* (bhimal) in Uttarakhand” in ICFRE- Forest Research Institute, Dehradun, Uttarakhand, India. This is an autoclave machine which works with 137 Pa (20lbs) pressure, was used for steam treatment (Abraham *et al.*, 2013). Steam explosion technique can be applied on the alkali treated fibre for one hour. Steam pretreatment is performed by loading the lignocellulosic material directly into the steam gun and treating it with high pressure steam at temperatures between 100–150°C. On the basis of this principal, Modified Steam Explosion Treatment Machine (MSETM) was fabricated (Fig. 1) and used to extract the *G. optiva* fibre and saponins as follows:



Fig. 1. Modified Steam Explosion Treatment Machine (MSETM) was developed by ICFRE- Forest Research Institute, Dehradun, Uttarakhand, India

G. optiva twigs (25 to 30 kg) (1m long) was taken and put them inside the drum. Lid of drum should be closed tightly. Set out the temperature after switch on of MSETM. Normally 151°C are kept. Switched on the compressor after ensuring water connectivity with the compressor. Water is sucked by compressor and takes 40 to 60 minutes to generate the steam. Check the meter of compressor if it is ok (steam level) then valve of compressor is to be opened to inject the steam into drum through high pressure tube. Run it for 1 hour for green *G. optiva* twigs and 2 hours for dry *G. optiva* twigs. After the incubation of curing time release the steam immediately from drum and after 10 to 15 min loosen the screw of lid of drum and remove it carefully. Taken out the *G. optiva* twigs from drum of machine and remove bark from all twigs manually within 15 to 30 minutes. Bark is removed very easily. Collected the bark and put again into drum to agitate half an hour for obtaining saponins. Saponins can be collected from bottom of the drum where valve is available to drain it. Thereafter, *G. optiva* bark collected, put into a steel pot and added one (19 gm) or two tea spoons of washing powder per litre of water and heat was given it for one hour. After one hour *G. optiva* bark with fresh water was washed out manually and obtained good quality of cleaned fibre. Spread cleaned fibre to dry it in Sun.

3. Chemical treatments and using other ecofriendly material to extract the fibre

Various chemicals such as Thio-Urea, Ammonium Oxalate, Urea and similar salts, etc. have been tried to help in retting to obtain the *G. optiva* fibre as follows:

(i) NaOH

Bark of *G. optiva* twigs were removed according to the above-mentioned method explained in Hot water treatment. Obtained Bark were boiled for 2 hours in different w/v concentration of NaOH solution i.e., 0.2%, 0.4%, 0.6%, 1% named T₁, T₂, T₃, T₄ respectively to remove lignocellulosic material of *G. optiva* twigs. Maximum dose of NaOH 1% w/v showed significant effect on fibre extraction as compared to other concentrations. After treatment with alkali the barks were washed with tap water and sun dried.

(ii) NaOH +Ammonium oxalate

Bark of *G. optiva* twigs was removed as per method explained in Hot water treatment. Obtained Bark were boiled for 1.5 hours in different w/v concentration of NaOH solution i.e. 0.2%, 0.4%, 0.6%, 1% named T₁, T₂, T₃, T₄ respectively with a constant amount of Ammonium Oxalate((NH₄)₂C₂O₄) i.e. 0.5% w/v in each experiment. After treatment with alkali and ammonium oxalate, the barks were washed with tap water and the extracted fibre was dried in Sun.

(iii) Urea

The twigs of *G. optiva* were divided into four bundles of length 1 feet and dipped into four different w/v concentration of Urea i.e., 0.2%, 0.4%, 0.6%, 1% named T₁, T₂, T₃ and T₄ respectively. The barks were left for retting for 46 days at room temperature and monitored regularly. The application of 1% w/v concentration of urea showed significant effect on fibre extraction and reduced retting time by 50% over the conventional method which take more than 90 days. The extracted fibre was then sun dried.

(iv) Thio-urea

Again, the twigs of *G. optiva* were divided into four bundles of length 1 feet length and dipped into four different w/v concentration of thio-urea i.e. 0.2%, 0.4%, 0.6%, 1% named T₁, T₂, T₃ and T₄ respectively. The barks were left for retting for 45 days at room temperature and monitored regularly. The application of 1% w/v concentration of thio-urea showed significant effect on fibre extraction and reduced retting time by 50% of *G. optiva* fibre in comparison to the traditional method that took more than 90 days. Extracted fibre was dried in the Sun.

(v) Cow dung treatment

Again, the twigs of *G. optiva* were divided into four bundles of length 1 feet length and dipped in four different concentration of freshly prepared cow dung solution i.e. 0.2%, 0.4%, 0.6%, 1% named T₁, T₂, T₃ and T₄ respectively. The barks were left for retting for 45 days at room temperature and monitored regularly. The cow dung was collected from FRI, Dehradun. 1% w/v solution of Cow Dung showed significant effect on fibre extraction and reduced retting time of *G. optiva* fibre by 48% compared to other traditional method that takes more than 90 days. Extracted fibre was dried in the Sun.

(vi) Control

Four bundles of 1 feet length twigs of *G. optiva* were taken and dipped into fresh water, run parallel with all the experiments at ambient temperature and experiment was terminated after 80 days, fibre was extracted manually and washed in tap water. Extracted fibre was dried in the Sun. After determination of optimum concentration of chemicals and other ecofriendly materials, 200gm fibre from *G. optiva* twigs were extracted from each method using optimum extraction concentration of chemicals in terms of ecofriendly, facile and energy efficient material.

4. Physico-Chemical characterization of *G. optiva* fibre

Physico- chemical properties of *G. optiva* viz., Fineness-Fibre denier, Breaking Strength, Tenacity, Elongation at Break (%), Fibre length, Fibre diameter, Moisture content and moisture regain and density of fibre were determined by Northern India Textile Research Association (NITRA), Ghaziabad, India.

5. Chemical characterization of *G. optiva* fibre

The natural fibres are derived of hygroscopic, cellular, heterogenous and anisotropic solid mass composed of cellulose and hemicellulose bind together by lignin. Apart from these three major building block units of natural fibre, inorganic compounds and organic extractives are also found in natural fibres in a certain amount.

5 (i) Determination of Holocellulose, Cellulose, Hemi Cellulose and Ash Content

The combination of cellulose and hemicellulose content present in lignocellulosic fibre is termed as holocellulose content of fibre and was determined using ASTM (D 1104) standard for wood (Abdullah *et al.*, 2013). The ash content of fibre was determined by using AOAC, 2000 standard (Owolabi *et al.*, 2012).

5 (ii) Determination of lignin content

The lignin content (%) was determined using TAPPI (T 222 om-02) standards for wood (Wise, (1946).

5 (iii) Total Nitrogen and Crude protein

Estimation of total nitrogen percentage determined by using the Pelican equipments viz; Macro Block Digestion system (model KES 08) and Automatic Distillation System (Model Classic DX).

Crude Protein % = Total Nitrogen % × 6.25 (based on assumption that nitrogen constitutes 16% of protein) as per Lowry *et al.* (1951).

III. RESULTS AND DISCUSSION

Grewia optiva is an important agro-forestry species. It is a multi-purpose tree providing leaf fodder, fibre, and fuelwood (Khosla *et al.*, 1992). Saponins are second metabolites which are widely distributed in the plant kingdom. It acts as a chemical barrier or shield in the plant defense system to counter pathogens and herbivores (Augustin *et al.*, 2011). Therefore, it is found in plant tissues that are most vulnerable to fungal or bacterial attack or insect predation (Wina *et al.*, 2005). The presence of both polar (sugar) and nonpolar (steroid or triterpene) groups provide saponins with strong surface-active properties (Makkar *et al.*, 2007). Their physiochemical and biological properties feature structural diversity, which have led to a number of traditional and industrial applications (Price *et al.*, 1987 & Oakenfull, 1981). Many saponins exhibit distinct foaming properties and bhimal saponin is one of them. They are also added to shampoos, liquid detergents, toothpastes and beverages as emulsifier and long-lasting foaming agent (Tanaka *et al.*, 1996).

For quantification of saponins, *G. optiva* twigs of various diameters were taken to determine saponins by following standard method mentioned in materials and methods and results are summarized in Table 1. Various mechanical treatments like hot water treatment, crushing of twigs of *G. optiva*, using perforated pot were tried for collection of saponins. In present study, saponins were observed on average upto 45% by following standard method (Table 1). Chen *et al.*, (2010) also reported saponins content of the *Sapindus mukorossi* crude saponins (85%) is double than the saponins content of the *Camellia oleifera* crude saponin (39.5%). *Camellia oleifera* has been used as a natural detergent and its extract is commercially utilized as a foam-stabilizing and emulsifying agent.

Table 1. Quantification of saponin in *G. optiva* twigs based on various diameters

Treatments	Twig dia (cm) of 1 fit long	W ₁ - Wt of evp. dish	W ₂ - Wt of evp. Dish + Powdered saponin	W- Weight of sample taken	Saponin %
T ₁	2.4cm	54.6248gm	55.9675gm	3gm	44.76%
T ₂	2.1cm	58.4338gm	59.4531gm	3gm	33.98%
T ₃	1.9cm	54.5739gm	55.770gm	3gm	39.8%
T ₄	1.8cm	58.3785gm	59.7605gm	3gm	46.06%
T ₅	1.7cm	54.6256gm	56.3695gm	3gm	57.11%
T ₆	1.3cm	58.4321gm	59.8273gm	3gm	46.50%
T ₇	1.2cm	58.432gm	59.7187gm	3gm	42.89%
T ₈	1.1cm	54.6237gm	56.0104gm	3gm	46.22%
				Average	44.67%

Traditionally fibre is extracted by using conventional method. Farmers cut the twigs and remove leaves of bhimal for use as fodder. After taking the fodder from twigs, they usually collect twigs and make bundles for putting into khall or gadhera (pond). These bundles are completely drowned in gadhera for more than 90 days. After taking out these bundles, fibre is extracted and dried in sunlight. However, they lost the opportunity to collect the saponin available therein by traditional method.

Various chemicals and ecofriendly materials were used as retting agent for extraction of *G. optiva* fibre such as NaOH, NaOH + Ammonium oxalate, Urea, Thio-urea and Cow dung treatment.

Maximum dose of NaOH 1% w/v showed significant effect on fibre extraction as compared to other concentrations. After macerating the bark and washing with fresh water, cleaned fibre was dried in Sun. The obtained Bark was dipped in the solution of NaOH + ((NH₄)₂C₂O₄) Ammonium Oxalate with various concentration (i.e., 0.2%, 0.4%, 0.6%, 1% of NaOH with a constant amount of Ammonium Oxalate i.e., 0.5% w/v) to remove lignocellulosic material from bark and

kept on heating object for one and half hour. Bark was macerated to obtain fibre manually after heating treatment and washed in running fresh water. The extracted fibre was speared in Sun for drying. The application of urea with concentration of 1% w/showed significant effect on fibre extraction and reduced retting time by 50% (46 days) of *G. optiva* fibre over the conventional method that take more than 90 days. Extracted fibre was dried in the Sun. The application of Thio-urea with concentration of 1% w/v showed significant effect on fibre extraction and reduced retting time by 50% of *G. optiva* fibre against the conventional method that took more than 90 days. Extracted fibre was dried in the Sun. Cow Dung of 1% w/v showed significant effect on fibre extraction and reduced retting time by 48% (47 days) of *G. optiva* fibre against the traditional method that takes more than 90 days. Extracted fibre was dried in the Sun.

From the above-mentioned treatments as well as in the control experiment, optimum doses were opted to extract the fibre from *G. optiva* and 200 gm fibre from each method was extracted for further studies. Similarly fibres from *F. glomerata* stems were extracted by using water retting method. After retting, the fibres were scoured using sodium hydroxide (NaOH) (Aaditaa & Jahan, 2018).

Modified Steam explosion treatment machines (MSETM) and shampoo collection etc. (steam treatment- Abraham et al. 2013)

Modified Steam Explosion Treatment Machine (MSETM) has been fabricated and used for extraction of saponins and fibre within a day from *G. optiva* bark as described in materials and methods. Stem bark of *G. optiva* is firmly stuck with twigs. This is best method using MSETM to remove bark easily and in short period. Obtained bark was put into fresh water mixed with full 1-2 tea spoon of caustic soda per litre and given heat for 1-2 hours. After removing the heating object, macerated fibre manually very easily, washed with fresh water and dried in Sun. In this whole process of twigs of *G. optiva* curing when experiment was conducted in 2020, 17 units of electricity were consumed to run 3 hours MSETM that fall Rs. 51 for 25 to 30 kg of *G. optiva* twigs steaming and agitating for obtaining saponins and fibre. The consumption of electricity may also be reduced automatically when increasing the attempts of steaming process. The washing powder cost is of Rs. 30-50 per Kg. When we collect the saponins and sell it out in market then our profit automatically will be increased and input cost will become zero. Fibre producers are in win-win situation if it is taken as business to extract the *G. optiva* fibre. This is the fastest method to obtain saponins and fibre within a day from *G. optiva* twigs to support the livelihood.

Physico-chemical properties of *G. optiva* fibre

As mentioned above 200gm *G. optiva* fibre was extracted from each method used with optimum concentration of chemical or eco-friendly material. Some physico-chemical properties of *G. optiva* fibre were also determined. Extracted fibre was sent to NITRA (Northern India Textile Research Association), (Linked to Ministry of Textiles, Government of India), Sector – 23, Raj Nagar, Ghaziabad – 201 002 (India) for determination of physic-chemical properties of fibre. Obtained results of *G. optiva* fibre are given in Table 2 as under:

Table 2. Some Physical strength properties of *G. optiva* fibre results of various treatments

S. No.	Physical Strength Properties	Treatments					
		NaOH	NaOH (2% w/v) +Ammonium Oxalate (0.5% w/v)	Thio-urea	Cow dung	Urea	Control
1.	Fibre denier	117.07	28.30	33.96	24.21	35	26.38
	CV%	24.87	38.69	25.08	40.47	23.15	25.73
2.	Breaking strength, (g)	351.25	93.42	97.23	70.51	108.34	87.88
	CV%	30.81	53.32	39.13	58.06	49.01	72.15
3.	Tenacity (g/denier)	3.12	3.37	2.98	3.00	3.11	3.24
	CV%		-	-	-	-	-

4.	Elongation at break (%)	3.85	2.34	2.15	1.74	2.57	2.19
	CV%	39.74	33.01	30.33	37.62	33.71	59.48
5.	Fibre length, (mm)	285.3	51.22	52.41	51.57	51.25	52.97
	CV%	19.38	28.93	27.47	33.29	31.99	32.92
6.	Fibre dia (micron)	73.64	51.28	55.02	38.12	47.26	41.84
	CV%	30.69	51.45	38.38	51.29	44.05	30.41
7.	Moisture Content%	7.72	8.64	8.19	8.76	7.74	8.63
	Moisture regains	8.37	9.46	8.66	9.60	8.34	9.45

The physical properties of extracted fibre were determined showed (Table 2) the results of tensile strength (fibre denier, breaking strength, tenacity, elongation at break), fibre length, fibre diameter, moisture content and moisture regaining ability of the differently extracted fibre s. The results showed that the maximum tensile strength was found in the fibre sample extracted from alkali treatment. The maximum breaking strength was found to be 351.25 (g) for the fibre extracted using NaOH with a fibre denier of 117.07(g/tex) and tenacity of 3.12 (g/denier). The fibre extracted from cow dung treatment was found to have minimum breaking strength of 70.51 (g) with a fibre denier of 24.21 (g/tex) and tenacity of 3.00(g/denier). The effect of chemical used in the extraction is directly proportional to the physical properties of fibre . The sample extracted in alkali showed better results as compare to the samples extracted using ether different chemicals. The maximum fibre breaking strength, fibre deniers, elongation at break and fibre length were acquired in the fibre extracted using alkali (NaOH). Hence, NaOH treated extraction was considered to get the better fibre from *G. optiva* in terms of both chemical and physical properties.

Chemical composition of fibre / some chemical properties of *G. optiva* fibre

The chemical compositions of *G. optiva* fibre extracted from different treatments are shown in Table 3. The results revealed that the maximum cellulose content observed was in Urea treated fibre (66.56) whereas the minimum cellulosic content was observed in control (48.98) which is a normal retting process. The fibre extracted by using NaOH with ammonium oxalate has cellulosic content of 51.27% other treatment was also given to extract fibre from *G. optiva* and it was found that cow dung treated, NaOH treated and Thio -urea treated fibre has cellulosic content 59.33%, 55.66% and 66.01% respectively. Hemicellulose is soluble in NaOH (Whistler& BeMiller, 1993) and this is the main reason for maximum hemicellulose content in control fibre i.e., 36.47% which depicts that it is less suitable for textile purposes. NaOH +Ammonium oxalate, cow dung, and NaOH extracted fibre has comparable hemicellulosic content which is 28.15%, 20.08%, and 23.08% respectively. The minimum hemicellulosic content was found in the fibre extracted using Urea (13.69%). The quality of fibre depends upon the amount of lignin and cellulosic content present in it. The NaOH extracted fibre has lignin content 19.18% and cellulosic content 55.66%, and was found to be feasible in terms of tensile strength properties, manpower and expenses invested during the extraction of fibre. The control has min amount of lignin but has maximum amount of hemicellulose present in it which enable it not to separate into proper fibril structures.

The data on the chemical composition of extracted fibre from *G. optiva* indicates that in the case of chemically extracted fibre i.e., from NaOH, there is more removal of hemicellulose as compare to control due to removal internal constraints which helps the fibre to becomes more capable of rearranging itself in a compact manner hence, improves the breaking strength of fibre . Hence, the NaOH treatment is more suitable for the application of natural fibre from *G. optiva* in various areas.

Table 3. Chemical composition of fibre / some chemical properties of *G. optiva* fibre results of various treatments

S.No.	Treatments	Lignin Content (%)	Holocellulose (%)	Cellulose (%)	Hemi Cellulose (%)	Ash Content (%)
1.	NaOH+ Ammonium Oxalate	17.17	79.43	51.27	28.15	4.76
2.	Cow Dung	21.10	80.16	59.33	20.83	3.35
3.	NaOH	19.18	78.75	55.66	23.08	6.59
4.	Thio Urea	20.12	80.42	66.01	14.41	1.55
5.	Urea	21.05	80.25	66.56	13.69	2.42
6.	Control	13.12	85.45	48.98	36.47	2.96

IV. CONCLUSION

In the present study, experiments were conducted on quantification and extraction of saponins and fibre from *Grewia optiva* twigs. This is the fastest method to obtain fibre within a day from *G. optiva* twigs to support the livelihood. Traditionally we can get either saponins or fibre which takes more than 90 days in process. So an advance technology for extraction of *Grewia optiva* (bhimal) for extraction of both saponins and fibre has been developed by fabricating of Modified Steam Explosion Treatment Machine (MSETM). With the help of MSETM, saponins and fibre of *G. optiva* within one day can be extracted without any bad smell and environmentally safe. There is first step to separate the bark quickly from *G. optiva* twigs by using Modified Steam Explosion Machine (MSETM) and process completes within 2-3hrs only. Then extracted bark is put into MSETM to agitate and collect sponins. After this bark is heated with 1-2 tea spoons (19 to 38 gm) of washing powder per litre water for 1 hr and macerate manually to obtain fibre and wash with fresh water. The washing powder cost is of Rs. 30-50 per Kg. When we collect the saponins and sell it out in market then our profit automatically will be increased and input cost will become zero. Fibre producers are in win-win situation if it is taken as business to extract the *G. optiva* fibre. The live demonstration of this developed technology for fibre extraction has been shown in the field and appreciated by participants. This is economic method developed. In *G. optiva* grown areas, people may earn money gracefully by using this technology for improvement of their livelihood.

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