Great Potential of Stinging Nettle for Sustainable Textile and Fashion

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Abstract Nettle is a common herbaceous plant, which regroups 30–45 species. It is part of the Urticaceae family such as ramie (Asian nettle, *Boehmeria nivea*) and belongs to the genus Urtica. The stinging nettle (*Urtica Dioica*) is the most prominent species in Europe and Himalayan ranges. This fibre also belongs to an ancient textile fibre. In this chapter deals with different aspects of sustainable process of production of fibre, methods of fibre extraction and their advantages, properties of nettle fibre, products from nettle and its blends. A comprehensive effort has been made to revamp the potentiality of sustainable development of fashionable textile and industrial materials from nettle fibre as well as form its byproducts. Overall, chapter covers various nettle-based handicraft and apparel products for luxury sector and their proper disposal.

Keywords Nettle fibre · Extraction of nettle fibre · Properties of nettle fibre · Sustainable nettle textiles · Application of nettle fibre

1 Introduction: *History, Production, Yield, General Introduction About Luxury Fibre, Utilisation of Fibre, Sustainability,* etc.

Nettle is one of the common herbaceous plants which clusters around 30–45 species. This bast fibrous material is part of the Urticaceae family such as ramie (Asian nettle, *Boehmeria nivea*) and belongs to the genus Urtica. The stinging nettle (*Urtica Dioica*) is the most prominent species in Europe. Since early 77

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BC, nettle fibre has been used for making hand-spun yarn and from it they prepare hand-spun twines using a fly wheel length of 30 cm [1, 2]. In those days, two methods of spinning nettle fibre for netting-lengths were used wherein fibres were coiled into basket pulled out and spun: (a) by rolling on thigh with palm of hand and (b) by using a spindle rotated on the thigh or leg by rolling. These hand-spun twines are used for fishing purposes. Recently, research investigation by Bergfjord et al. [3] established the Lusehøj textile (National Museum of Denmark B26436), found in 1861/2, was wrapped around cremated human remains and placed inside a bronze urn. The fabric is a dense and balanced tabby weave with approximately 16 threads/cm in both thread directions. The yarn is fine and evenly spun, having yarn diameter ranging 0.3–0.5 mm and twist direction of S-twist twist used in both warp and weft. After investigation through different scientific identification studies (scanning electron microscopic, polarised microscopic view and specific chemical test) they confirmed that the fibre used was nettle and it was around 2800 years old (940–750 BC) which matches the typological and contextual dating. Findings also revealed that those nettle fibres were imported from Kärnten-Steiermark region in the south-western area of Austria.

Nettle grows on rich soils and up to 1.20 m high. It has been established that yields and fibre content of originally produced nettle were higher in the third year of cultivation than those achieved before cloning process was adopted in nettle cultivation [4]. The fibre yield ranged 335–411 kg/ha in the second year and from 743 to 1016 kg/ha in the third year. Previously, It has been established that highest strength of nettle fibres falls in the range of the fibre strength of cotton, i.e. 15–50 cN/tex [5].

Baltina and Lapsa [6], scientists from Latvia reported that nettle cultivation in their country produces textile grade fibre. To obtain large number of fibres, special nettle clones from *U. dioica* L. should be used. However, the nettle does not require planting every year, rather it can be grown for several years. The obtained yield of fibre is less than that of flax and hemp. The bast content in nettle straws is about 20 % and it is less than in flax and hemp. The fibre strength varies in a wide range and has greater unevenness. The interesting part of the nettle plant is that the longer the plant life, stronger the fibres that can be obtained from them. Moreover, it is not necessary to use wide nettle plant spacing, rather, it decreases the amount of bast content and strength of the fibres.

In India, Uttarakhand, Himalayan nettle, widely available in the wild, is an underutilised biomass product [7]. The durability and eco-friendly nature of nettle fibres extracted from these plants are an added advantage to their versatility for use across seasons. As a natural fibre suitable for both winter and summer garments, Himalayan nettle has been of interest among both lifestyle and sportswear garment manufacturers in the textile industry. Indeed, there is a high export potential for nettle fibres. In the domestic market, multiple uses of nettle make it ideal for the handicrafts sector, which also provides value to the tourism industry. According to the Uttarakhand Bamboo and Fibre Development Board (UBFDB), more than 15,000 tonnes of raw nettle is available in the state [7].

2 Sustainable Fibre Extraction: *Different Methods of Fibre Extraction from Bark, Their Process, Merits and Demerits*

2.1 Extraction Methods of Nettle Fibre

Huang [8] has suggested that the best fibre properties can be obtained after several processes. In this he recommended that after harvesting the green bundled plants are retted for 2 weeks in pond. After this the bast portion can be separated easily from the woody core nettle plant. These retted fibres are unsuitable to produce better spinning performance. They proposed 15 stages involving biological and chemical process for efficient cleaning of nettle fibre from green harvested nettle fibres to process successfully in spinning machinery for yarn preparation. Overall though the process produces well separated nettle fibres with good spinning performances, huge amount of chemicals and steps are involved in making the nettle fibre ready for spinning.

In another study by Dreyer et al. [9], the green nettle plants were retted followed by drying and then fibres separated by mechanical extractor. These mechanically extracted nettle fibres were allowed to treat separately with three different treatments, viz. chemical, enzymatic and steam exploded processes. During comparison of these three treatments, they concluded that the enzymatic process of fibre separation of coarse nettle has good potential for producing fine and strong nettle fibres. Similar amount of fibre separation can be obtained from chemical treatment wherein alkali has been used as a major chemical. They concluded that considering the environmental impact and other related aspects, the enzymatic process is the best among these three methods of fibre separation of nettle fibres whereas the chemical treatment leads to environmental pollution and steam explosion required huge amount of heat energy. Considering the above aspects, Bacci et al. [10] have experimented different methods of retting and fibre extraction. From their studies it can be confirmed that both controlled microbiological retting with the combined use of anaerobic and aerobic bacteria and vat enzymatic retting, especially when a solution of Pectinex Ultra SP-L with EDTA (ethylene di-amine tetraacetic acid) was used, led to improvement in fibre quality.

3 Evaluation of Properties: *Physical and Chemical Properties of Nettle Fibre*

3.1 Physical Properties

Physical properties especially the strength is much superior to commonly used natural fibres like cotton, silk, wool and base fibres. The average fibre length, diameter and tensile strength vary between 43 and 58 mm, 19 and 50 μm and 24

Table 1 Comparative properties of some single bast fibres

Fibre	Young's modulus (GPa)	Strain to failure (MPa)	Ultimate stress (%)	Density (g/cm^3)	Average diameter (μm)
Nettle	87	2.1	1594	0.72	20.0
Flax	58	3.3	1339	1.53	23.0
Hemp	35	1.6	389–900	1.07	31.2
Ramie	20–128	1.2–3.8	400–1000	1.56	50.0
Sisal	9–21	3–7	350–700	1.45	100–300
Glass	72	3.0	2200	2.54	5–25

and 62 cN/tex respectively [11, 12]. Bacci et al. [11], highlighted that unlike flax and hemp fibres, nettle fibre lies along the length of the plant stem and beneath the surface of the outer bast layer and the fibres present on this surface are fine and long. However, the extension is little higher than jute fibre (2 %). Surprisingly, nettle fibre fibres are very light and their density is 0.72 g/cm^3 which is half of the other natural fibres. Table 1 presents nettle and some important bast fibres and compared with glass fibre [13, 14].

The cultivated wild nettles exhibited longer stems and a mean fibre content of 50–66 % [15]. Though, the relative diameter of single wild nettle fibre is finer (14.51 ± 0.19 μm) than that of cultivated nettle fibre diameter (22.11 ± 11.94 μm) in UK.

Recent studies by Haugan and Holst [16] developed theoretical model for distinguishing natural fibres like jute, nettle, cotton, etc. and found that the fibril structure and their angle is different for all fibres based on polarised microscopic views and birefringence results. Figure 1 depicts sign of elongation of nettle fibre. The modified Herzog test was performed for jute and nettle fibre as shown in Fig. 2.

Bodros and Baley [13], also studied the cross-sectional view of nettle stem by SEM (under 1000×) presented in Fig. 3. It depicts, fibre bundles are located at the inner cortex. It is also visible clearly from figure about the lumen at the centre. The fibres' cross-sections are mostly polygonal. They considered circular cross-section and estimated the average fibre diameter to be 19.9 μm (±4.4).

It has been reported that typically 5–8 % is the moisture regain behaviour of nettle fibre [21].

Davies and Bruce [17], found that nettle fibres are brittle due to small strain to failure, which resembles the flax fibre brittleness. They concluded that the flax fibre behaved in a linear elastic manner to the point of failure, but the nettle depicted limited viscoelastic effects. The static Modulus of the fibres was independent of fibre strain. The dynamic modulus increased with increased strain at a rate of 13 GPa/% strain and 6 GPa/% strain for flax and nettle fibres respectively.

An interesting study on comparative stress strain properties of nettle and flax fibre has been investigated by Bodros and Baley [13] (Fig. 4).

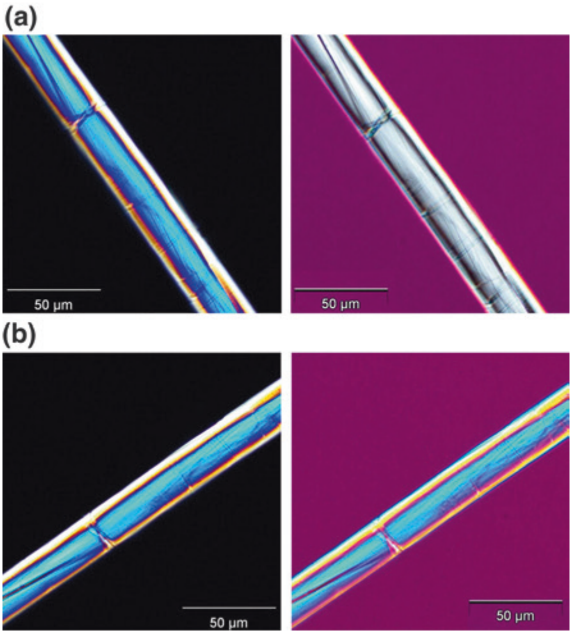

Fig. 1 Demonstration of sign of elongation. **a** $\alpha = 45°$. **b** $\alpha = 135°$. Fibre is nettle. At $\alpha = 45°$ zero-order grey is clearly observed, which proves the expected positive sign of elongation [16]

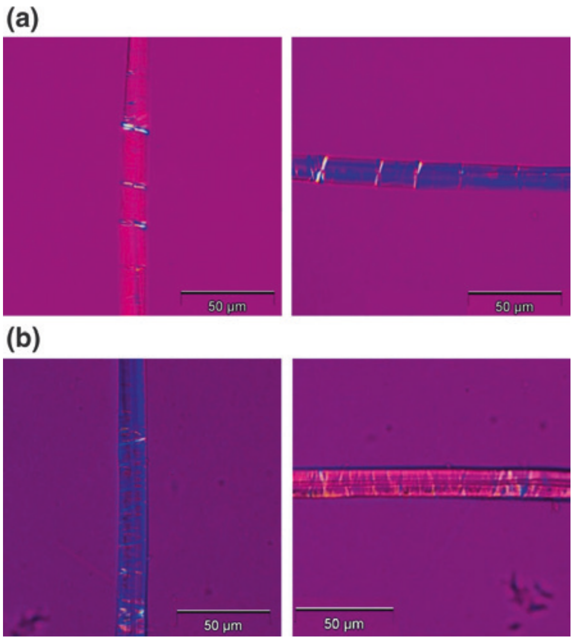

Fig. 2 The modified Herzog test performed on (**a**) nettle (S-twist) and (**b**) jute (Z-twist). To the left the sample orientation angle $\alpha \approx 0°$, to the right the sample orientation angle $\alpha \approx 90°$ [16]

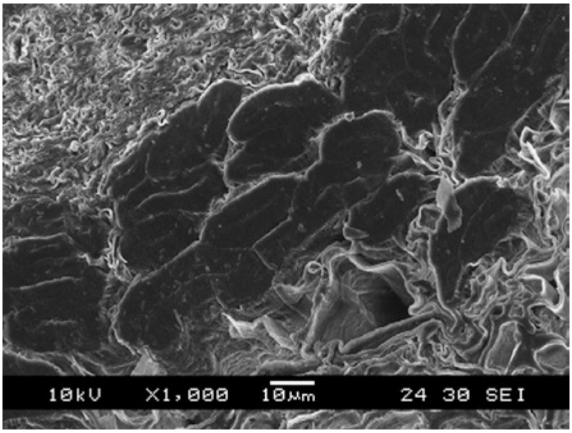

Fig. 3 Cross-section of a stinging nettle (*Urtica dioica*) stem under SEM [13]

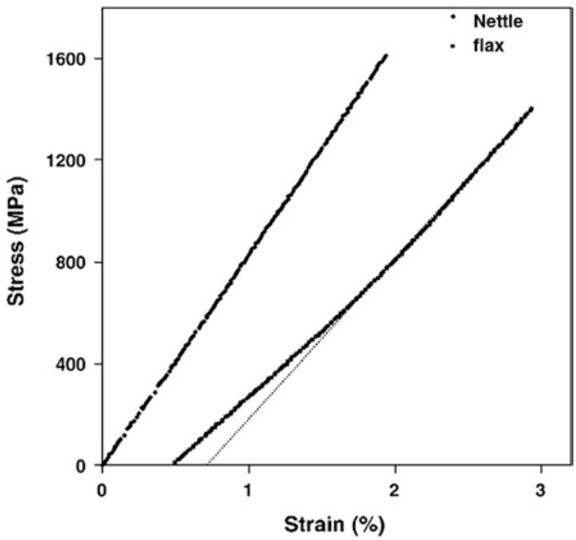

Fig. 4 Stress/strain curves of nettle and flax fibres [13]

3.2 Chemical Properties

As far as the nettle fibre is concerned, major chemical composition elements present are cellulose 79–83.5 %, hemicellulose 7.2–12.5 % and lignin 3.5–4.4 % [11, 18].

Distinguishing between the bast fibres is possible based on X-ray microdiffraction method, but as the method requires the use of a synchrotron it is not readily available; moreover, it is costly. Bergfjord and Holst [19] proposed a simple procedure for identifying different bast fibres measuring the fibrillar orientation with polarised light microscopy and detecting the presence of calcium oxalate crystals (CaC_2O_4) in association with the fibres. This procedure required a small amount of fibre material.

3.3 Mechanical Properties of Stinging Nettles

Bodros and Baley [13] adopted a process to measure the single nettle fibre tensile strength where the gap between the two jaws and cross-head speed were maintained at 10 and 1 mm/min respectively. Young's modulus, stress and strain at failure are measured for 90 fibres. The average tensile properties are a Young's modulus of 87 Pa (±2.8), a tensile strength of 1594 MPa (±640) and a strain at failure of 2.11 % (±0.83). The ultimate stress is greater for nettle fibres in comparison to ramie and equivalent to that of flax [20]. Harwood et al. [15] used advanced textile instrumentation system to evaluate the relative fibre diameter (Sirolan TM Laserscan), length (Uster High Volume Instrument), strength and cleanliness (Uster Microfibre Dust and Trash Analyzer) of extracted fibre using standard procedure.

4 Sustainable Development of Luxury Textiles and Other Industrial Applications: *Sustainable Development Different Luxury and Fashionable Value Added Textiles from Fibre, Yarn and Fabrics, Their Properties and Probable Uses of Nettle in the Luxury World*

4.1 Sustainable Chemical Processing of Nettle and Value Added Textile, Composite Product Development

Research work reveals that nettle fibre needs to bleach prior to dyeing so that it can be treated as cellulose [21]. Nettle naturally has an off-white colour and will therefore require bleaching prior to any dyeing. Hydrogen peroxide bleaching as preparation of the fibre irrespective of its original shade is most essential for removal of the extraneous matters present in the fibre. These bleached nettle fibres facilitate better levelling and dye uptake during the dyeing process. Though, the natural colour nettle is often too deep to remove completely while bleaching with hydrogen peroxide treatment hence, two-stage sodium hypochlorite bleach followed by hydrogen peroxide bleach is suggested. These two stages of bleaching are required especially to dye nettle fibre with light colour shades. As far as dyeing is concerned, nettle fibres, unlike other natural cellulosic fibres, can be dyed effectively with reactive dyes or in some cases with direct dyes. If the clothes are to be used for work wear where more sustainable dyes are likely to be required, reactive dyes, vat dyes or sulphur dyes would be the right selection.

One has to concentrate upon some important properties as far as the sustainable luxury apparel is concerned, like shrinkage, pilling, etc. It has been reported that nettle fibre has good shrink resistant behaviour [21]. They have good dimensional stability and more interestingly, fibres tend to have higher strength when wet than in their dry state. As far as the resistance is concerned, Matthew [21] also confirmed that nettle fibres are extremely durable and resistant to abrasion and pilling. There is immense possibility to use this nettle fibre for sustainable development [22] in making packaging material, upholstery, tarpaulin, geotextile, bags and carpets, etc.

Today, people are more conscious about eco-friendly processing for sustainable development and in the same line, Vogl and Hartl [1], discuss about the different aspects of production and processing of organically grown nettle fibre. Further, they also emphasised its potential use in the natural textile industry in spite of its different important industrial applications. Bhardwaj and Pant [23] demonstrated nettle and acrylic blended textiles. In their experiment they used 70:30, 50:50 and 30:70 nettle:acrylic blended fibres for development of value added nettle–acrylic blended fashion textiles. It has been reported and concluded that 100 % nettle of linear densities of 16_s Ne and 24_s Ne yarn are not possible to spin successfully due to fibre stiffness and poor pliability. However, in blends of 70:30 nettle:acrylic also huge breakages during spinning were produced. Other blends are quite acceptable in terms of yarn hairiness, evenness, imperfections and tensile properties. Shaolin et al. [24] in China used nettle fibre grown natively and used to develop nettle as core-spun yarn for coarse yarn used in development of fashionable upholstery.

There are huge potentials to develop various textile and industrial products for different technical applications out of nettle fibres. Various parts of the fibre nettle plant can be used as food, fodder and as raw material for different purposes in cosmetics, medicine, industry and biodynamic agriculture [1]. Developing new natural fibre composites is one of such areas wherein nettle fibres have good contribution to impart the final composite strength. Bodros et al. [25]. Bodros and Baley [13, 26] focused that nettle fibres being renewable resources have a lower environmental impact in comparison to mineral fibre (glass) composites. They measured the mechanical performances of stinging nettle fibres and compared to flax and other lignocellulosic fibres. The stress/strain curve of stinging nettle fibres (*U. Dioica*) shows they have a linear behaviour which can be explained by the orientation of the cellulose microfibrils. In composites, the average tensile properties are a Young's modulus of 87 GPa, a tensile strength of 1594 MPa and a strain at failure is 2.11 %. However, in the light of biocomposites from nettle Saheb and Jog [27], commented that since nettle unlike other natural fibres contains moisture so for maximum utilisation of strength in composites the moisture has to be removed prior to composite manufacturing process.

In one of the experiments, Kuciel et al. [28] developed and tested biocomposites based on poly-hydroxybutyrate (PHB) filled with four types of natural fibres—wood, kenaf, horse hair and nettle. They found that nettle fibre formed microfibers in the composite structure which enhances the strength of the total composite (Fig. 5).

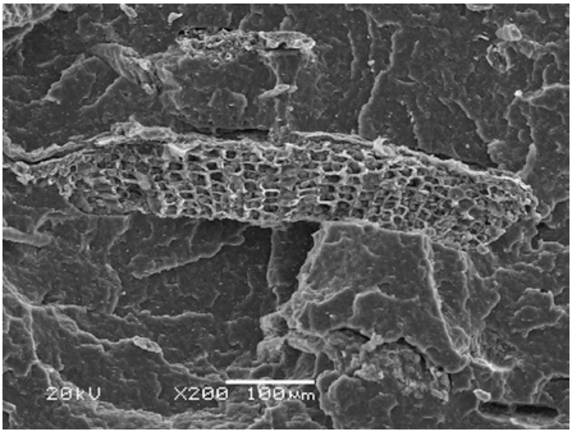

Fig. 5 SEM image of fracture PHB +15 % nettle fibres, single nettle fiber build from many microfibers [28]

4.2 Nettle Yarn Spinning for Value Added Products

English [29], explained in this research about the history of spinning, weaving and knitting machines, wherein, nettle fibres have been used traditionally for spinning of yarn and those yarns are further used for apparel fabrics apart from their industrial applications. Dunsmore [30, 31], also explained the importance of nettle fibre processing and hand spinning of nettle yarn considering different situations in Nepal. She also described the hand weaving of nettle fabric and different possibilities of fashion apparels out of sustainable nettle fibre. Zuo et al. [13], applied different spinning systems and techniques, for sustainable spinning of the nettle fibres. Their results show that the nettle fibres cannot be used for spinning singly because the main length of nettle fibres is very short, discrete coefficient of length and fineness is varied. However, admixed with other fibres, the test-yarn qualities are somewhat acceptable. Their research output can be useful for developing sustainable and fashionable products from the wild nettle fibres.

Choudhary et al. [7], reported that at the primary level, the sector involved in nettle processing, has high involvement of women, who harvest the plant from the forest, extract the nettle fibre and spin the thread. Traditional technology for extracting bast and spinning thread has been small-scale with high inefficiencies both in terms of labour and energy. Weavers use these threads to produce different fabrics, including scarfs, shawls and cloth material. Market acceptance of the end product has been low to date due to roughness of the fabrics and limited colour choices. To overcome these problems, Choudhary et al. [7], developed special spinning process to spin 100 % nettle and nettle–cotton blended yarn. Their process sequences involve: straightening, cutting, first crushing, washing, conditioning (degumming), second crushing, pre-carding and softening. After these processes the main carding followed by drawing and spinning are performed. With the intervention of these processes the nettle processers can fetch more money because the yarn productivity is higher and of better quality. Choudhary et al. [6], finally explained the value-chain of Himalayan nettle for sustainable development of the nettle product at Uttarkhand, India.

Yan et al. [32] studied the spinnability of nettle fibre in textile process apart from its basic physical and mechanical properties. They made an effort to spin in different spinning systems and technologies. In all the cases spinnability of the nettle fibres has been studied. Their results show that the nettle fibres cannot be used to spin alone because overall lengths of the nettle fibres are very short, discrete, coefficient of length and fineness is varied widely. However, nettle can be mixed with other fibres for better spinnability. On the contrary, the test results of yarn qualities are not satisfactory for pure nettle yarn.

Spinnability of nettle fibres was studied in friction spinning system by Shaolin et al. 2005. In friction core-spun yarn of nettle, nettle fibres blended with short flax fibres as wrapped fibres and polyester short fibres as core yarn were developed. Influence on yarn performance of spinning speed, friction roller speed and core yarn percentage was researched by orthogonal test method. They also optimised the spinning parameters of friction core-spun yarn technology range of nettle fibre. A crop of the perennial stinging nettle plant (*U. dioica*) was established in Leicestershire, UK in 2005 by Harwood et al. [15] and sampled weekly throughout the growing season in 2006 and 2007 for investigation of fibre content and growth characteristics. They studied its suitability for spinning on cotton and woollen systems and found that nettle fibre was suitable for woollen spinning. The fabric comprising 80 % wool and 20 % nettle fibre was found optimum and produced for corporate upholstery use. The high variability in fibre length and lack of uniformity of nettle fibre prohibits its use in cotton spinning system. Further they concluded that the relatively low yields of fibre obtained from the plant made low value non-woven markets which was unattractive and uncompetitive at that point of time. However, the greatest price for nettle fibre is to be found in the higher end and fashionable textile markets.

4.3 Nettle for Sustainable Traditional Handicrafts

The stem and fibre of stinging nettle are used to prepare traditional handicrafts in several Balkan countries as reported by Dogan et al. [33]. This nettle fibrous material in Bulgaria locally known as *Kopriva* is used for sustainable development of cloth, sack, cord and net manufacturing application. In Romania, nettle is known as *Urzica*, and its use is substitute of cotton for fishing net and paper making. It is known as *Kopriva* in Serbia, where nettle fibre is considered as one of the major textile fibre and used for spinning industry to produce textile products. Overall, there are wide ranges of possible handicraft products (doormat, flower vase, wall-hangings, door-chain, carpet, hand-bags, table-mat, beach umbrella, lampshade, etc.) out of nettle either from fibre or yarn or fabric or combination of these. All these products have huge profit margin due to high cost to benefit ratio. Most of the handicraft products fall under fashion items. Similarly, Dunsmore [30], in her findings explained different handicraft products made out of nettle fibres and hand-spun yarn from Nepal. This study also elaborates the sustainable rural livelihood through cultivation of nettle to handicraft product development out of nettle. This handcraft making from nettle fibrous material for rural hill people created an alternative source of income during the lean period of agricultural activities. Economic development of the nettle processing community of Nepal has been through proper marketing strategy and exporting the fashion textile and handicraft products to Europe and America. Bacci et al. [10] also supported that for sustainable handicraft products from nettle it is very essential to go for enzymatic retting to obtain best quality fibre. Deokota and Chhetri [34], reported in their research the handloom and handicrafts are moved side-by-side to promote nettle-based products in Nepal. These include, coarse hand-woven cloths, sacks, bags, fishnets and *namlo* (headstraps to carry load) which are sold in the local market or in some cases bartered for food or other necessary items in some rural communities. Anonymous [35] demonstrated various sustainable fashion products made out of nettle like hat, jacket, room decoration and various handicraft products, which can be made out of nettle and its blends.

4.4 Nettle Apparel: Its Laundering Behaviour and Disposal

Nettle can be blended well with other fibres to develop fashion apparel as suggested by Matthew, [21]. Under the luxury apparel category, it can be used in some apparel such as fashion dresses, jackets and suiting; heavy weight fabrics are more suitable for jackets where hard wearing properties can be obtained. Due to unique appearance of nettle fibre, nettle fabric has also a unique look and is suitable for development of winter garments. It has been suggested that nettle, nettle–wool, nettle–cotton, nettle–ramie and nettle–flax are possible natural fibre blended material that can be used for development of 100 % natural sustainable textile materials [1, 8, 15].

Laundering plays an important role for any textile material as far as its repeated use is concerned. Nettle-based fabrics can withstand laundering at high temperatures [21]. These should only be used for heavily soiled garments. Unlike flax fabrics, nettle-based fabrics are also prone to becoming creased during washing and this will require the use of a hot (steam) iron during pressing. Dyes have a tendency to bleed and suitable separation during washing should be taken care. If required, tumble-drying requires a high temperature setting. Unlike cotton, nettle can be treated with a crease resistant finish, which can improve the "easy care" nature of the nettle fabrics sustainably. Treated fabrics should be laundered in accordance to instructions as these may recommend lower heat settings during drying and ironing though nettle can withstand high laundering temperature.

Since nettle is annually renewable so no such issue of depletion of natural resources arises (Fig. 6). It has been also reflected through this Fig. 6 that except

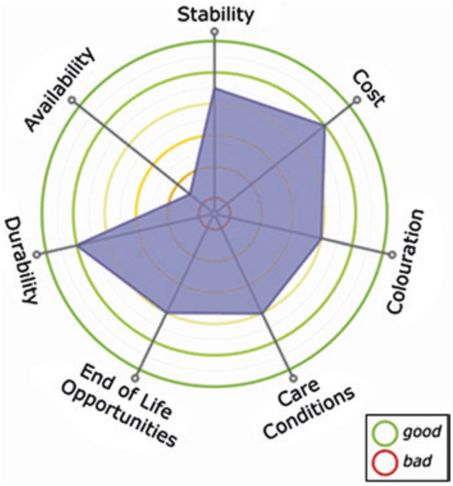

Fig. 6 Polar diagram of comparative aspects of nettle fibre [21]

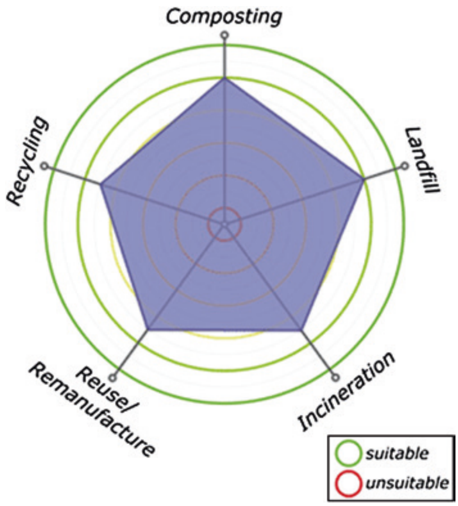

Fig. 7 Disposal of nettle textiles [21]

the availability of nettle fibre, most other aspects like, disposability, durability, colouration, etc. are acceptable compared to other natural fibres. Hence it can be figured out from these facts that nettle can well be used as sustainable luxury textiles. Characteristics/options defined by the polar diagram are proportionally represented and approximate. As such they do not represent any industry standards. Apart from these, fabric construction and weight and content of other blended fibrous material (in case of nettle blended products) will influence the perceived ranking.

After subsequent usage of the nettle-based textiles, it can be disposed off using all end of life opportunities (Fig. 7). It can be handled in a similar way as other natural cellulosic fibres materials are disposed. Nettle fabrics also have huge potential to be reused or re-manufactured and can also be used as a source of cellulose feedstock for regenerated cellulose products. Being naturally biodegradable, the fibres can be composted in some cases if required [21] as presented in polar diagram.

4.5 Probable Uses of Nettle in the Luxury World

There are immense evidences of using nettle products in the luxury world. Considering the holistic approaches available from different sources, the various applications of nettle fibre are in the form of fibre, yarn, fabric and composite structures. Hand-made braided structures are prepared in different rural areas near which nettle is grown. These braids are used to make luxurious and fashionable items [33, 30] like hand-bags, door-chain, wall-hangings, decorative items for rooms and car interior, flower vase, etc. Fibre/yarn/fabric or combination of these structures is coated with natural/synthetic resin to make the stiff to semi-stiff composite structures. These composite structures including paper from nettle are generally used to make different luxury products like lampshade, fruit basket other table-top decorative items [33]. As far as apparel is concerned, nettle in the form of blended structure, wherein nettle–cotton, nettle–flax, nettle–wool, nettle–viscose, etc. are used to weave union or blended fabrics [33, 35]. These fabrics are mostly coarser and heavier in nature due to inherent coarseness of the nettle fibre. Close-woven structure for winter apparel and open-woven structure for summer apparels are common applications of these products apart from fashion garments [21]. The economically established society is able to embrace the usage of costlier and health friendly natural fibre products as compared to economically underdeveloped backward society.

5 Conclusions

This chapter discusses about the stinging nettle fibre's uses in sustainable textile and fashion. This fibre can be cultivated and hence no question of depletion of forest trees as well dependency on petroleum reserve. It has been found from the above study that though the stinging nettle is one of the oldest textile fibres but with the intervention of modern synthetic/manmade fibres its application has been restricted. With latest scientific knowhow this nettle fibre can be extracted sustainably to a greater extent without affecting its quality. Simultaneously, the byproducts released and extracted during the fibre extraction process as well as different potential components can be uses for various value added sustainable products. There is huge potential in textile and other non-textile industries like pharmaceutical due to its medicinal values both for human as well as animals, composites for bio-composite and high strength, application for sustainable fashion textiles and natural dyes from its own plant extraction to produce ethnic sustainable textiles. Hence a comprehensive effort needs to be taken to revamp the potential of sustainable development of fashionable textile and industrial materials from nettle fibre as well as from its byproducts.

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