Processing used in analysis of medicinal properties of plants after post harvest" –A Review

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Abstract: **Over the last two decades, there has been a significant surge in interest in traditional systems of medicine, particularly herbal remedies, in both developed and developing countries. The global and national markets for therapeutic plants are quickly expanding, resulting in huge economic gains. Despite their widespread use, various reports reveal that the quality of herbal products on the market is inconsistent. The fact that herbal remedies are complex to produce accounts for the variance in quality. Good agriculture and collection/harvesting methods have recently been acknowledged as a key instrument for maintaining the safety and quality of a number of medicinal plants and their products in recent years. This article examines the issues, developments, and future prospects for systems for collecting and post-harvest processing medicinal plant resources in order to produce high-quality herbal medications on a long-term basis. To produce a high-quality, effective herbal drug, the appropriate part of the medicinal plant must be harvested at the optimum stage of development, dried and stored at temperatures and conditions that do not degrade the active ingredients, and processed using a method that maximizes phytochemical recovery. Only by following all of these procedures can a high-quality product with batch-to-batch consistency be produced .In this way, the safety, efficacy, and quality of herbal products can be maintained, and billions of dollars can be invested in the country's burgeoning herbal markets.**

Keywords: **collection, processing, analyzing, resources, remedies.**

1. INTRODUCTION

Medicinal plants form the foundation of basic health care for the vast majority of the population, as well as a vital source of income for many rural people, particularly those living near forests. For more than 80% of the population in underdeveloped nations who rely on traditional medical systems, they provide a source of primary health care. Herbal medications have also grown in popularity in recent years as their acceptability has grown in both developing and developed countries. The comeback of herbal drugs is largely owing to the recognition of many contemporary drugs' negative side effects. The growing demand for herbal medicines prompted a surge in large-scale commercial harvesting from the wild. With the rising demand for medicinal plants, the supply chain is being strained, resulting in destructive harvesting and adulteration of legitimate pharmaceuticals (Schippmann, 2002).According to research, gathering medicinal herbs in the wild is still the primary source of supplies. Currently, 90% of medicinal plant collection is done in the wild, resulting in about four million man days of work (part-time and full-time), and because 70% of plant collection includes destructive harvesting, many plants have become endangered, vulnerable, or threatened (Anonymous 2000; Larsen and Olsen, 2007; Hamilton, 2008; ISS-MAP). Medicinal plants are being overexploited as a result of increased demand, and many have been pushed to the brink of extinction (Ved and Goraya, 2008) .The quality of medicinal plants is determined by their geographical origin, species cultivar, growth stage at the time of harvest, and post-harvest management. The stage of maturity, processing, and storage receives little attention (Pandey and Das, 2014).As a result, the quality of the product suffers .The raw material supply situation is fragile, unsustainable, and exploitative in most cases. The industry is highly clandestine, uncontrolled, and rapidly expanding. Despite the abundance of resources (biological, human, and financial), the sector has remained stagnant due to a lack of sustainable harvesting procedures, appropriate processing and storage facilities, and quality control. Several valuable medicinal plants can be found in India. The important medicinal plants growing and collected in central India, based on information gathered from the literature (Gupta et al., 2005; Pandey and Mandal, 2010; Pandey and Yadav, 2010; Pandey and Mandal, 2012; Pandey and Das, 2014).It includes information on their common and botanical names, as well as information on the parts utilised, medical purposes, and harvest dates. I t also contains details on the most important active components that are responsible for biological action.

Internal and external factors influence medicinal plant yield and quality, such as appropriate species identification, harvesting/collection time and manner, and post-harvest practices such as drying, storage, packaging, and processing.

Identification-:

Due to a variety of factors, most medicinal plants utilised by traditional practitioners and producers of Ayurvedic goods are taken from the wild, making identification and getting uniform quality material difficult.

A plant name can sometimes refer to multiple species: 'Brahmi' might refer to either Bacopa monneiri or Centella asiatica, which have completely distinct phytochemical compositions.

Shankhpushpi is a Rasayana drug in Ayurveda, and several plant species have been reported as Shankhpushpi, including Convolvulus pluricaulis, Clitoria ternatea, Evolvulus alsinoides, and Tephrosia purpurea in different parts of India, but Convolvulus pluricaulis is the official drug in the Ayurvedic Pharmacopoeia of India (Shah and Bole, 1961; Singh and Vishwanathan, 2000). The impact of agro-climatic conditions on the chemical composition and therapeutic qualities of a medicinal plant species is also well-known; seven varieties of Terminalia chebula from various parts of India are known to have diverse therapeutic properties.

Table 1: List of important Medicinal plants collected from central India.

S. No.	**Common Name**	**Botanical Name**	**Par Used t**	**Uses**	**Month in which harvested/ collected**	**Major active ingredients**
1	Brahmi	*Bacopa monnieri*	Leaf, entire plant	Memory enhancer	Mature herb is harvested Jan-Feb.	Bacoside, saponin glycosides
2	Giloe	*Tinospora cordifolia*	Stem	Immunomodulator, antipyretic,	Stem is harvested in Nov-Dec.	Tinosporoside, cordioside
3	Jamun	*Syzygium cumini*	Fruit, seed, bark	Diabetes	Fruits are collected July-August	Anthocyanins, glucoside, ellagic acid, myrecetin. Seeds contain alkaloid, jambosine, and glycoside jambolin
4	Neem seed	*Azadirachta indica*	Seed, leaf, pulp	Insecticide	Seeds are harvested in June-July	Azadirachtin, fatty oil
5	Tulsi	*Ocimum sanctum*	Leaf, seeds	leucoderma, asthma, heart disease	Leaf and branches are harvested July November.	Terpenes, sesquiterpenes, uric acid

Developmental Stage of Harvest-:

To achieve the highest possible quality of source materials, medicinal plants should be gathered during the right season or time period.The concentration of essential chemical contents (active ingredients) is well known to be substantially influenced by the developmental stage of growth as well as the season (Pandey and Das, 2014) [10].

The phytochemical content is directly influenced by the plant's developmental stage.Andrographis paniculata (Kalmegh) is a prominent ayurvedic herb that is employed as a heaptoprotective herb in a variety of ayurvedic formulations.

According to Pandey and Mandal (2010) [11], the largest level of andrographolide (2.85 percent) was detected in A. paniculata gathered 130-150 days after planting (at the time of initiation of flowering).In Ayurveda, **Brahmi** is utilised as a brain tonic. Bacosides are responsible for the action. The herb's bacoside -content was shown to be high from September to March, as well as in June. June and September through November were ideal harvest months for high bacoside -A yields (Mathur et al, 2002).

Wihania somnifera (**Ashwaganda)** is harvested 130-180 days after planting, while Tinospora cordifolia (**Giloe**) is harvested when fully mature (after 15 months).Quantitative research found that, with the exception of alkaloid concentration, all phytoconstituents rose as the diameter of the stem increased (Pandey and Das, 2014).

Table 2: Time and method of collection of different plant parts.

S.NO.	Plant parts	Time and method of collection
1	Bulbs	Long after the plant has flowered and fruited, in late October.Bulbs should be dug from a distance of several meters away from the parent plant.Collect mature large bulbs while leaving little bubs to regenerate.Unless otherwise noted, bulbs/roots should only be gathered following seed shedding.It makes it easier for species to regenerate.
2	Bark	Autumn (after the leaves have fallen) or spring (after the flowers have bloomed) (before development of leaves).Using a thin flexible blade/bush knife, remove the bark in long vertical strips. Stem bark should not be harvested from the same tree again unless it has had enough time to grow entirely. Ring barking, or the removal of complete rings from a tree, is not recommended.
3	Root and rhizomes	Shortly before flowering, from annuals. Following the first year's growth, from biennials in the autumn or winter. Following the second or third year's growth, harvest perennials in the autumn or winter. Dig the root far enough away from the main stem or tap root, at least 30 cm. The tap root should not be severed. Don't take all of the plant's roots. Only collect the lateral roots.
4	Leaves	The best time to collect is when the plant is flowering and the weather is dry. Instead of leaf striping, pluck individual leaves and avoid using harsh pruning shears on leaves. In some plants, collecting in the morning yields a high-quality output (solanaceous leaves).Unless otherwise noted, leaves should be picked before or at the start of flowering.
5	Flowers	Collection should take place in dry conditions and early in the morning, after the deadline has passed. Harvest blooms with care to avoid injuring the plant's main stalk. To capture the perfume of the flowers, they must be gathered quickly after they have opened.
6	Seeds and fruits	Fruits should be collected when completely grown and ripe or nearly ripe, unless otherwise specified. It is preferable to collect slightly sooner to avoid seed dissemination. Only gather fruits from a few trees in forest areas, leaving the rest to regenerate. Branches of the tree or shrub should not be clipped to make fruit and seed harvesting easier.
7	Annual herbs/ whole plant	Annual herbs should be collected as soon as they begin to blossom. Harvesting the entire population of a specific area is never a good idea. To facilitate future collections, a enough population should be left for regeneration.

Collection/Harvesting of Medicinal plants-:

To achieve the highest possible quality of both source materials and finished products, medicinal plants should be collected/harvested at the right season or time period. The quantitative concentration of physiologically active phyto components varies with plant growth and development, as is well known. Rather than the total vegetative output of the targeted medicinal plant parts during harvest, the ideal period for collection/harvest (quality peak season/time of day) should be selected based on the quality and quantity of biologically active elements (Pandey and Mandal, 2013, Pandey and Das, 2014) .To achieve the highest possible quality of both source materials and finished products, medicinal plants should be collected/harvested at the right season or time period.The quantitative concentration of physiologically active phyto components varies with plant growth and development, as is well known.Rather than the total vegetative output of the targeted medicinal plant parts during harvest, the ideal period for collection/harvest (quality peak season/time of day) should be selected based on the quality and quantity of biologically active elements (Pandey and Mandal, 2013, Pandey and Das, 2014).

1. Sustainable harvesting procedures should be used while gathering medicinal herbs.

2. Medicinal plants should be picked in the best conditions possible, avoiding dew, rain, and extremely high humidity. If harvesting takes place in wet conditions, the harvested material should be moved right away to an indoor drying facility to hasten drying and avoid any negative consequences from increased moisture levels, which promote microbial fermentation and mould.

3. In general, the plant materials that have been collected/ harvested should not come into direct touch with the soil.

If underground portions (such as roots or rhizomes/bulbs) are harvested, any soil that adheres to the plants should be removed as quickly as possible.

To reduce the microbial burden of harvested medicinal plant materials, contact with soil should be avoided as much as possible. If necessary, big drop cloths, ideally made of clean muslin, can be used as an interface between the harvested plants and the soil.

4. Clean baskets, mesh bags, other well-aerated containers, or cloths should be used to collect/harvest plant material that is free of extraneous matter, including plant leftovers from earlier collecting efforts.Following collection, the plant materials may be treated to appropriate preliminary processing, such as hand selecting to eliminate unwanted materials and pollutants, washing (to remove extra dirt), sorting, and cutting.

5. The gathered raw medicinal plant components should be conveyed in a clean, dry environment as soon as possible. They can be loaded into clean baskets, dry sacks, trailers, hoppers, or other well-aerated containers and transported to the processing facility from a central location. If the collection site is far from processing facilities, the raw medicinal plant components may need to be air or sun-dried before being transported.

6. If more than one portion of a medicinal plant is to be collected, the various plant elements should be collected and transported in separate containers. At all times, cross-contamination should be prevented.

Any mechanical damage or compacting of the raw medicinal plant components, such as overfilling or stacking of sacks or bags, that could cause composting or otherwise degrade quality, should be avoided. To avoid microbial contamination and product quality loss, decomposed medicinal plant materials should be recognized and eliminated after harvest.

7. Insects, rodents, birds, and other pests, as well as cattle and domestic animals, should be kept away from the medicinal plant materials.

8. Machetes, shears, and mechanical tools are examples of collecting/harvesting implements (tools) that should be kept clean and in good working order. Excess oil/grease and other pollution should be avoided on sections that come into direct touch with the medicinal plant materials. To avoid damage and contamination from soil and other materials, cutting devices, harvesters, and other machines should be maintained clean and adjusted. They should be kept in a clean, dry environment free of insects, rats, birds, and other pests, and out of reach of cattle and domestic animals.

Primary processing-:

In order to maintain the quality of the herb after harvest, primary processing procedures such as drying, storing, and packing are critical. The key factors impacting the quality of fresh herb during storage are temperature and relative humidity. Raw plant materials that have been harvested or collected should be unloaded and transferred to the processing facility as soon as possible. Plant pieces should be transported in separate containers. When you arrive at the processing centre, unpack it right away. Prior to processing, the plant materials should be kept from rain, moisture, heat and any other circumstances that could cause deterioration. Direct sunlight should only be used to dry medicinal plant components when there is a specific necessity for it. During the primary-processing stages of production, all medicinal plant materials should be inspected, and any poor products or foreign matter should be removed mechanically or by hand. To remove discoloured, mouldy, or damaged materials, as well as soil, stones, and other foreign matter, dried medicinal plant materials should be inspected, sieved, or winnowed. Mechanical equipment, such as sieves, should be cleaned and maintained on a regular basis. Insects, rodents, birds, and other pests, as well as cattle and domestic animals, should be kept away from all processed medicinal plant products to prevent contamination and decomposition.

Washing

During the primary-processing stages of production, all medicinal plant materials should be inspected, and any poor products or foreign matter should be removed mechanically or by hand. To remove discoloured, mouldy, or damaged materials, as well as soil, stones, and other foreign matter, dried medicinal plant materials should be inspected, sieved, or winnowed. Mechanical equipment, such as sieves, should be cleaned and maintained on a regular basis. Insects, rodents, birds, and other pests, as well as cattle and domestic animals, should be kept away from all processed medicinal plant products to prevent contamination and decomposition.

Drying

The most frequent method for preserving the quality of medicinal plants is to dry them. The moisture content of medicinal plants determines their physical and chemical qualities. The removal of water, or drying, is the initial step in many postharvest procedures. Drying is the process of reducing the moisture content of plants in order to inhibit enzymatic and microbiological activity and, as a result, preserve the product and extend its shelf life. Appropriate dryers are required for this purpose, which use temperature, velocity, and humidity values to dry air, resulting in a quick reduction in moisture content without harming the quality of medicinal plant active components. The most frequent method for preserving the quality of medicinal plants is to dry them. The moisture content of medicinal plants determines their physical and chemical qualities. The removal of water, or drying, is the initial step in many postharvest procedures. Drying is the process of reducing the moisture content of plants in order to inhibit enzymatic and microbiological activity and, as a result, preserve the product and extend its shelf life. Appropriate dryers are required for this purpose, which use temperature, velocity, and humidity values to dry air, resulting in a quick reduction in moisture content without harming the quality of medicinal plant active components.

When preparing medicinal plant materials for use in dry form, the moisture level of the material should be kept as low as possible to avoid mould and other microbial invasion.

Medicinal herbs can be dried in a variety of methods, including the following:

1. in the open air (shaded from direct sunlight)

2. Placed in thin layers on drying frames, wire-screened rooms, or buildings in the open air (shaded from direct sunshine).

3. if possible, in direct sunlight (fleshy material).

4. In solar dryers and drying ovens/rooms.

5. Using indirect heat sources such as indirect fire, baking, lyophilization, microwave, or infrared equipment.

6. Drying using a vacuum

7. Spray dryer: papaya latex and pectins, for example.

Drying using a vacuum

This is done in steam-heated ovens with perfect closure, and the vapour-laden air is expelled using a pump.

The low pressure inside the oven allows for quick and full drying.

Advantages of vacuum drying

1. Rapid drying.

2. Relatively low temperature.

3. Cleanliness and freedom from odour and dust.

4. Independence of climate conditions.

5. Control of temperature.

6. Elimination, of risk of fire.

7. Compactness.

Storage

1. Packed dried crop should be stored in a dry, well-ventilated structure with little diurnal temperature change and enough air ventilation. Be prepared with air conditioning and humidity control equipment, as well as rodent, insect, and cattle protection if necessary. Wire screens should be used to keep pests and farm and domestic animals out of shutter and door openings.

2. The floor should be well-kept, free of cracks, and simple to clean. Plant material should be stored on shelves that keep the material away from the walls; precautions should be taken to prevent pest infestation, mould formation, rotting, or oil loss; and inspections should be conducted at regular intervals.

3. Continuous in-process quality control methods should be undertaken before to and during the final stages of packing to eliminate substandard materials, contaminants, and foreign matter. Standard operating procedures and national and/or regional requirements of the producer and end-user countries should be followed when packaging processed medicinal plant materials in clean, dry boxes, sacks, bags, or other containers.

4. Packaging materials should be non-polluting, clean, dry, and undamaged, and should meet the quality criteria for the medicinal plant materials in question. Rigid containers should be used to package fragile medicinal plant products.

5. Dried medicinal plants and herbal medications, including essential oils, should be preserved in a dry, well-ventilated space with minimal daily temperature variations and adequate aeration.

6. Fresh medicinal plant materials should be stored at low temperatures, ideally between 2 and 8 degrees Celsius; frozen items should be kept below -20 degrees Celsius.

7. Small amounts of crude pharmaceuticals could be stored in airtight, moisture-proof, and light-proof containers like tins, cans, covered metal tins, or amber glass containers. The storage of crude pharmaceuticals should not be done in wooden crates or paper bags (WHO, 2003; Anonymous, 2009).

Personnel

1. Personnel handling medicinal plant material should: -maintain a high level of personal hygiene; -have access to appropriate changing facilities and restrooms with hand washing facilities.

2. Employees should not be allowed to operate in the herbal material handling area if they have been diagnosed with, or are carriers of, a condition that could be transmitted by medicinal plant materials, such as diarrhoea.

3. Personnel with open wounds, sores, or skin infections should be moved away from places where herbal materials are handled until they have fully healed.

SNP therapy enhanced the visual quality

Carrot taproots were sprayed with four different concentrations of SNP solutions and ddH2O (the control group) to identify the optimal concentration of SNP for preserving the appearance quality of postharvest carrots. Carrots treated with SNPs showed reduced black spot coverage as compared to controls; the 1.5 mM SNP treatment group displayed the greatest phenotype. Subsequent investigation revealed that SNP therapy (1.5 mM) lowered the pace of weight loss when compared to control. Additionally, the effects of 0.5 mM cPTIO therapy on carrot taproots were assessed in order to learn more about the role that NO plays in preserving the postharvest quality of carrots at room temperature. Samples treated with cPTIO had greater rates of weight loss, poorer sensory scores, and greater degrees of colour change difference when compared to the control and SNP treatment groups. According to these findings, the ideal treatment dose was 1.5 mM SNP, and NO was crucial in preserving the postharvest carrots' aesthetic quality(Y Xiao,2024).

Melatonin stimulates treatment- The physiological problem known as "chilling injury," which causes internal browning in cold-stored pears, is irreversible and severely limits the postharvest handling and commercialization of pears. This study examined the effects of melatonin (MN) therapy on the development of chilling injury in 'Yali' pears, as well as the metabolism of sugars, proline, ascorbic acid (AsA), and γ-aminobutyric acid (GABA). When compared to untreated control fruit, the results showed that pear fruit treated with MN had a significantly higher tolerance to chilling stress. Proline accumulation was increased during MN administration, most likely due to increased transcriptional concentrations and activities of Δ1-pyrroline-5-carboxylate synthase and ornithine-δ-aminotransferase, as well as decreased transcriptional levels and activities of proline dehydrogenase. The GABA shunt pathway-related enzyme activity and gene expression were elevated by MN immersion, which raised the GABA concentrations in cold-stored pear fruit. In addition, the fruit's AsA concentrations increased after MN treatment, which had the beneficial impact of preventing cell membrane damage and lessening the negative effects of oxidative stress brought on by chilling. Fruit treated with MN showed decreased neutral invertase enzyme activity and gene expression as compared to the control group. Furthermore, MN treatment boosted the activity and gene expression of sucrose-phosphate synthase and sucrose synthase in pear fruit. These findings suggested that the control of proline, GABA, AsA, and soluble sugar metabolism may be linked to the improved chilling tolerance of 'Yali' pear fruit after MN treatment (L Liu, A Huang,,2024).

UVB treatments for ready-to-eat salads that are packaged

Using non-destructive fluorescent sensors, the effects of the UVB treatments on epidermal phenolics, chlorophyll, and photosynthetic parameters were tracked every day for a duration of six days during storage. Destructive HPLC-DAD examination of photosynthetic pigments and phenolics, as well as antioxidant capacity tests and fresh weight loss calculations, were carried out at the conclusion of the experiment. In comparison to unirradiated controls, the UVB treatment raised the epidermal phenolics (EPhen) Index, but it had no effect on the levels of carotenoids and chlorophyll or on photosynthetic efficiency. Fifteen hours following the initial UVB application, alterations in the EPhen Index were seen for both species. Subsequently, wild rocket outperformed baby-leaf lettuce in terms of response time, reaching the maximum phenolic level in less than one-third the energy dose required by lettuce. In comparison to controls, UVB-treated samples showed increased amounts of flavonoids (mostly quercetin derivatives) (48–67% and 37–66% in wild rocket and lettuce, respectively). Both UVB therapy and storage had no effect on the amount of carotenoid and chlorophyll in leaves. For the first time, we demonstrated that RTE salad leaves could be treated with through-packaging UVB radiation to increase the amount of total phenolic and quercetin derivatives. We also shared more information about the kinetics of phenolic compound elicitation by UVB in postharvest leaves. The food sector can benefit from our findings since they can be used to optimise possible UVB treatments by choosing the most effective wavelengths, intensities, single or repeated doses, and applications.

Citral treatmentcitrus fruit's resilience to disease after harvest.

Citral, a naturally occurring monoterpene found in citrus peel, Litsea cubeba, and Cymbopogon flexuosus volatile oils, can improve postharvest citrus fruit's resilience to disease and lessen Penicillium digitatum-induced fruit deterioration. Global changes in fruit treated with citral were analysed using RNA-seq, metabolomics, and biochemical studies to elucidate the defence mechanism contributing to the increase of disease resistance. Citral fumigation was successful in suppressing citrus green mould, according to the results. Citral boosted the activities of polyphenol oxidase, peroxidase, and phenylalanine ammonia-lyase. This was followed by higher levels of lignin, flavonoids, and total phenolics. Citral treatment led to the accumulation of several phenylpropanoid metabolites, such as curcumin, cinnamyl alcohol, hesperidin, syringin, 7-methoxyflavonol, vitexin-2-O-rhamnoside, coniferin, naringin, kaempferol-7-neohesperidoside, and trans-cinnamaldehyde, as well as the plant hormones methyl jasmonate, abscisic acid, and indoleacetic acid. Citral was found to significantly upregulate the expression levels of several genes implicated in the profiles of jasmonic acid (JA) and phenylpropanoid biosynthesis, according to RNA-seq data. These results provide new theoretical support for the management of postharvest citrus green mould by citral fumigation, and they imply that the JA pathway plays a positive role in the disease resistance that citral induces in citrus fruit(Bin Duan,2024).

Extraction

According to Shi et al. (2002), extraction is a crucial step in the production of botanical preparations and describes the bulk diffusion of target solutes from an insoluble plant solid to its surrounds. The process of extraction can be summed up as follows: solute solubilization in the solvent, chemicals desorbing from plant matrix, solvent transport into particles, and solute molecules diffusing into the bulk liquid. Selecting the right solvent and extraction method is essential for botanical preparations because target solutes and phytochemicals have diverse properties. There are numerous methods for preparing phytochemicals, including pressurised liquid, liquid-solid, supercritical fluid, and pressurised hot water extraction.

Pressurized hot water extraction

A recent extraction technique called pressurised hot water extraction (PHWE) involves extracting the target phytochemicals using hot, liquid water. Pressurised systems can achieve liquid water at temperatures between 1008C and 3748C, which is the critical temperature of water (Hawthorne et al., 2000). When it comes to removing polar phytochemicals from plant matrices, PHWE is very helpful. It's interesting to note that whereas water has an e of 80 at 208C and atmospheric pressure, liquid water at 2508C has an e of 27. The dielectric constants of methanol (e¼33) and ethanol (e¼24) at 258C are rather close to this latter number. Put another way, water can have the characteristics of some organic solvents if the temperature is raised.

The high water temperature in PHWE is a disadvantage since it exposes the phytochemical to deterioration. However, PHWE is an inexpensive and eco-friendly method of preparing plants provided the targeted phytochemical can withstand a high water temperature.

According to Miller and Hawthorne (2000), raising the temperature from 25 to 2008C enhanced the solubility of liquid organic taste and aroma compounds in hot or liquid water by a factor of up to 60. Polar flavour components were extracted by employing water at 100–1758C to extract taste and aroma molecules from savoury and peppermint (Kubatova et al., 2001). From the biomass of Satureja hortensis, more than 80% of the following compounds were extracted: thymol, carvacrol, borneol, linalool, and thymoquinone (Kubatova et al., 2001).

When paclitaxel was extracted from Taxus cuspidate using PHWE, the yield of the extraction decreased as the water temperature rose over 1408C (Kawamura et al., 1999). Using PHWE at 100 and 1408C, respectively, paclitaxel yields of 0.2 ~ 0.0 and 0.8 ~ 0.1 mg/g dried bark were achieved. According to Kawakura et al. (1999), the values obtained with PHWE (0.9 ~ 0.1 mg/g dried bark, 1508C methanol) fell within the range of those obtained with PLE. Iban˜ez et al. (2003) found that PHWE procedures allowed for selective extraction of antioxidant chemicals from rosemary leaves. They extracted the compounds using water at 25, 100, 150, and 2008C. The antioxidant activity of the extracts made via PHWE and supercritical fluid extraction of rosemary leaves was similar. Milk thistle seed meal was treated with PHWE at 100–1408C to extract silymarins (Duan et al., 2004). At higher temperatures, compound degradation became a significant issue, however the rate of extraction increased dramatically with temperature (maximum extraction yield in 200 min at 1008C, maximum yield in 55 min at 1408C). In conclusion, water can be utilised as an extraction solvent because it is cheap, easy to dispose of, and good to the environment. It is crucial to remember that the target phytochemical or phytochemicals must not be degraded, since the breakdown of thermally labile active molecules may result in unfavourable biological activity.

2. CONCLUSION

Through collection/harvesting, processing, and trade, the medicinal plant sector has the potential to improve local people's livelihoods. These efforts have the potential to become an important part of the country's forest and biodiversity management. The sector can generate rural income, employment, and livelihood prospects through value-added processing at the local level and efficient marketing. Small and microbusiness development, particularly for the processing and selling of medicinal plants, appears to have the potential to provide income opportunities for the poor. In this way, the safety, efficacy, and quality of herbal products can be maintained, and billions of dollars can be invested in the country's burgeoning herbal markets. To sum up, this review examines how several important pre- and post-harvest conditions affect the phytochemical makeup of medicinal plants and the products made from them. The right portion of the medicinal plant must be harvested at its peak development, dried, and stored at temperatures and conditions that don't lower the concentrations of phytochemicals. The extracted material must then be processed in a way that optimises recovery of phytochemicals. Only when each of these procedures is followed can a superior product with consistent quality from batch to batch be produced.

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