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1. Introduction

Non timber forest products are an important source of livelihood in rural economy. They are collected by rural population and sold in fresh form. Shelf life of the NTFPs can be enhanced by proper processing and drying. Primary processing is done before products are brought to markets. Basically there are three methods used in processing viz., primary processing, secondary processing, and complex method,

Primary processing is a method where with locally available resources and manpower value is added to products. Some processing techniques are very specific. Drying process is also an important procedure during primary processing. Among post harvest techniques, drying plays a vital role and is an important unit of operation under post harvest process. Dried products can be stored for a longer time without deterioration, since the micro organism which cause the spoilage are unable to grow and multiply in the absence of water.

Moisture is present in two forms viz.,

- Surface (free moisture)
- Core (Inside)

Hygroscopic (core) moisture drying involves removal of

- Free moisture
- Hygroscopic moisture
- Combination of both

Factors affecting drying are initial moisture, humidity and temperature. Selecting the right drying technique is important and difficult as every drying method has some limitations.

The different types of drying methods are:

- Sun drying
- Hot air drying
- Freeze air drying
- Vacuum air drying

Drying assisted desiccant based humidification systems.

Dehumidifying dryers works on the principle of maximizing evaporative potential.

2. Review of literature

Muller J and Albert Heindl (2006) suggested different types of dryers suitable for specific plant organs like leaves, flowers, roots or seeds, special emphasis is laid on the choice of drying temperature because of its strong influence on economic parameters such as drying capacity, energy requirement and recycling of exhaust air in drying.

Balakumbahar *et.al.* (2010) studied the effect of different drying methods on the respective alkaloids contents of *Gloriosa superba*. The study revealed that, sun drying of *G. superba* seeds on black polythene sheet under open drying conditions reduced the drying time whereas, in mechanical drying method increase in drying air temperature significantly reduced the drying time.

Bhatnagar *et. al.* (2003) and (2007) standardized primary processing and drying protocols for 20 NTFPs mainly under sun drying and shade drying condition in respect of leaves, flower and stems, also included

oven drying for tubers and estimated driage percent.

In recent years, mechanical drying has gained importance because of many advantages over sun drying. For preservation of active ingredients of medicinal plants comparatively low drying temperatures are recommended and as a result, the drying duration is comparably long.(Qaas and Schicle, 2001)

Like many other crops, medicinal plants and NTFPs have to be dried before storage. Drying can be defined as decreasing moisture content (MC) to preserve the product for extended shelf life. Micro organisms, like fungi, yeasts and bacteria, increasingly develop at relative humidity $RH > 70 \%$. Since the activity of decomposing enzymes is also enhanced by increasing water activity, a threshold of $RH \leq 60\%$ is recommended to preserve the quality of plant parts during storage (Muller and Heindle, 2006) For various medicinal plants species a maximum value of final moisture content is prescribed ranging between 8-12 %.

The proposal attempted to standardize primary processing and drying technologies for 15 NTFPs.

3. Objectives

- i. To standardize primary processing and drying techniques of NTFPs including medicinal plants of commercial importance.
- ii. To find optimal drying conditions.

4. Methodology

- i. Five samples with three to five replicates of selected species were collected in the season and green weight taken. Following details listed in a slip, giving name of division, range, collection place and date, fresh weight at collection time.
- ii. For some species like, Tikhur and Kalihari samples were processed by cleaning, peeling, cutting, etc. techniques depending upon nature of species.
- iii. The samples were weighed at periodic intervals ranging from few days to few months as per requirement and dried till moisture of acceptable limit was obtained using different techniques.
- iv. The experiment was carried out with different treatments with three to five replications for each treatment. Data was statistically analyzed for each species.

Treatments proposed for drying.

T1 - Sun drying

T2 - Hot air oven drying at 40-50 °C

T3 - Solar drying on wooden trays.

T4 - Shade drying under room condition.

- v. The driage percent was estimated as under:

$$\frac{\text{Green weight} - \text{Dry weight}}{\text{Initial wt.}} = \quad \times 100$$

The experiment revealed effect of different drying methods, duration period of drying and drying rate of each species under open conditions, drying in oven and through solar drying.

1. *Emblica officinalis* (Aonla)

Introduction

Emblica officinalis is a moderate sized tree met with wild or planted, common in mixed deciduous forests. Leaves are leathery with small narrowly oblong pinnately arranged leaflets. Popularly known as Indian goose berry, this species is valued for its fruits which are nutritious and have medicinal properties. The importance of this tree is mentioned in ancient texts. It is regarded as an important sacred tree of India. The tree is worshipped in Kartik as propitious and chaste.

The flowers appear from March to May and the fruits ripen from November to February. The fruit is highly nutritive and is the richest source of vitamin C. It is frequently found wild as well as cultivated throughout Madhya Pradesh. Its fruits are collected and sold for income either as raw fruit or in dry form. The state is one of the largest producer of aonla in raw form.

Aonla has gained economic importance in view of its medicinal properties and its use in several preparations. Fruit of aonla is juicy and has a sweetish sour taste. If taken regularly it helps maintain good health. It is believed that the aonla fruit juice contains five different constituents necessary for the normal functioning of the digestive system (Pimplashar, n.d.).

All medicinal plants/tree parts which have commercial value are under tremendous pressures. Unsustainable harvesting using destructive methods and with few cultivation attempts is leading to depletion of aonla trees.



Processing and driage

To standardize processing and drying technique of raw aonla fruit, an experiment was undertaken in SFRI. Samples of aonla were collected during the fruiting season and green weight taken on the site. Sample of medium to big sized aonla fruits (mixed lot) were collected from South Panna Division and small sized fruits from Shikara range, North Seoni Division and weighed.

Three replicates of the samples from both Forest Divisions, weighing 1 kg each were par boiled, deseeded and dried in sun for six days.

Table 1 : Driage percent of raw Aonla from different Forest Divisions

<i>Division</i>	<i>Fruit size</i>	<i>Green wt. (gm)</i>	<i>No. of fruits</i>	<i>Dried wt. (in gms)</i>	<i>Seed wt. (gms)</i>	<i>Driage percent</i>
S. Panna (Devenagar range)	Medium to large (mixed lot)	1000	60	163.96	64.0	83.6
N. Seoni (Shikara range)	small	1000	85	137.90	120.5	86.2

The driage per cent ranged between 83.6 to 86.2 per cent for South Panna and North Seoni division as given in. Table 1

Since raw aonla is fleshy in nature it is prone to microbial contamination in presence of moisture. Before transportation, spoilt fruits should be removed. It should be transported quickly. Dried aonla should be stored dry free from dampness and insects. It should be packed and stored in cool and dry place.

2. *Chlorophytum sp.* (Safed musli)

Introduction

Chlorophytum borivillianum and *Chlorophytum tuberosum* are most sought after medicinal herbs. They are widely distributed in Madhya Pradesh and are perennial herbs belonging to the family liliaceae commonly found in all forests. The genus *Chlorophytum* has about 175 species of rhizomatus herbs found in tropics of the world. *Chlorophytum borivillianum* is an indigenous medicinal plant found in the forests of Madhya Pradesh, it is commonly known as safed musli, Khairwa in Uttar Pradesh, Sufeta Musali in Maharashtra and Dholi Musali in Gujarat. Considerable trade is reported for both the species.



Although literature reports of several species but in commercial terms only two are known in the state. They are:

- i. *Chlorophytum borivillianum*
- ii. *Chlorophytum tuberosum*

Safed musli is widely used in Ayurvedic preparations.

Table 2 : Processing and driage percent of *Chlorophytum borivillianum*

<i>S. No.</i>	<i>Treatment</i>	<i>Fresh wt. (gm)</i>	<i>Days</i>	<i>Mean dry wt</i>	<i>Driage percent</i>
1.	Sun drying	1000	3	127	87.3%

Five replicates weighing 1000 gms were processed and dried for three days. Mean dry weight was 127 gms with 87.3% driage.

Since the fleshy tubers are prone to contamination due to presence of moisture, it should be packed in woven sacks with LD liner. The room should be dry and free from dampness, rodents and insects. Lots should be numbered with plant details, date of collection, test report details, best before use, etc.

3. *Aegle marmelos* (Bael)

Introduction

A small or medium sized tree found in mixed and miscellaneous and sal forests. It is also cultivated. The unripe or half ripe fruit is regarded as astringent, digestive and stomachic. When used in the form of sherbet, marmelosin is the active constituent; it acts as a laxative and diuretic. The greenish – white fragrant flowers appear from May to July and the fruits ripen by December. The fruit is globose (2-4" in diameter), grey or yellowish, and with a smooth hard aromatic rind. The fruits of cultivated trees are much larger in size. Seeds are numerous, oblong, compressed with a mucous testa.



The unripe fruits are beneficial in diarrhoea and dysentery. The ripe fruit is sweet, aromatic and cooling. The root bark and sometimes the stem bark is also administered in intermittent fevers.

Nowadays the gummy mucous substance surrounding the seeds is used as an adhesive and substitute of Jigat for binding agarbatties. Mixed with lime it is utilized as cement and the mixtures sets firm rapidly. Its leaves are also used for religious offering.

The fruit is used in powder form or sherbets are made. For marketing the fruit pulp should be whole, preferably unbroken. Size of the fruit varies and sometimes prices vary according to the size of the fruit.

An experiment was undertaken in SFRI for processing and estimating driage percent of bael. Ripe fruits were collected from Chapara Range, Seoni. After weighing, the fruits were spread out in the sun for drying for 3 days so that the hard outer covering cracked in the hard sun. They were then collected and put in for boiling in water and dried for 1-2 hours. The hard outer cover was taken out by light hammering and entire round pulp was extracted.

The bael fruits were then dried in the sun for 10-15 days. The fruits were turned upside down so that they dried on all sides.

Table 3: Processing and driage of *Aegle marmelos*

<i>S. No.</i>	<i>Sample</i>	<i>Fresh wt. of fruits (in gms.)</i>	<i>No. of fruits</i>	<i>Average wt per fruit (in gms.)</i>	<i>Total wt. of fresh pulp (in gms.)</i>	<i>Driage days</i>	<i>Dried wt. of pulp</i>	<i>Driage percent (%)</i>
1.	R1	1000	5	200	572	10	265	73.5
2.	R2	1000	6	166.6	899	10	269	73.1
	Avg.	1000	5.5	183.3	735	10	267	

The average weight of the dried fruit was 267 gms and driage percent 73% as given in Table 3

Before storage, spoilt and unripe fruit should be discarded. The fruit is edible so it should be stored in clean dry place in high gauge woven sacks with LD liner. The room should be dry, free from dampness, insects, birds, rodents free.

Lots should be numbered giving name of raw drug, plant part, inspection status, test report details, best use before and time of collection.

4. *Buchanania lanzan* (Chironji)

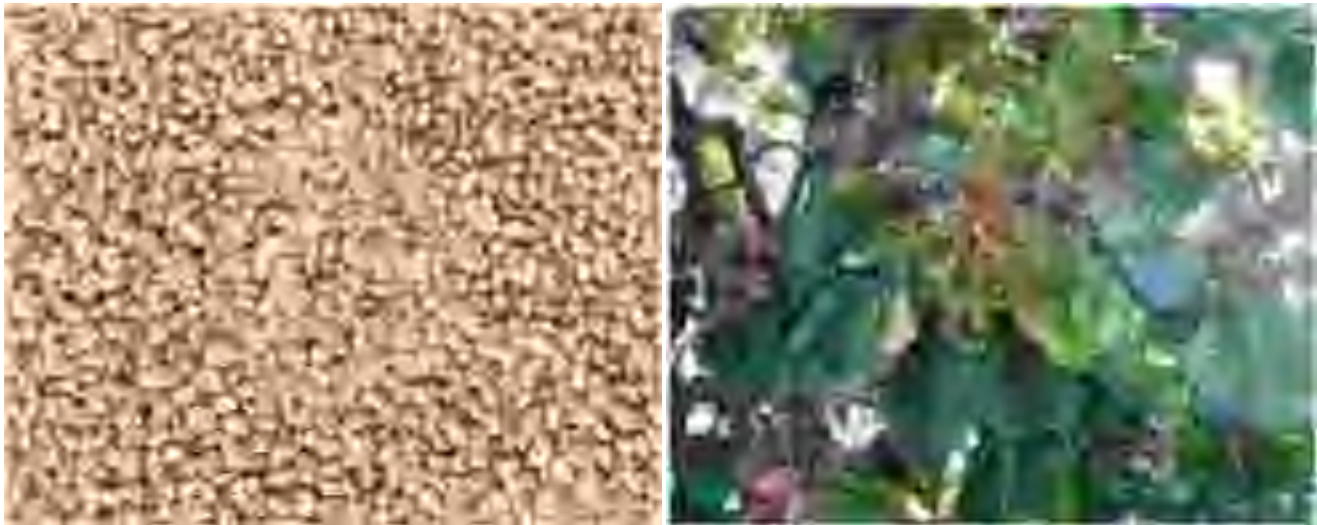
Introduction

Buchanania lanzan occurs both in forests and in agricultural land. Greenish white flowers appear between January to March and the fruits ripe from April to May. The fruit falls before the commencement of rainy season. The collection of Chironji is done in the month of May. It is mainly collected by farmers from their agricultural field and by rural population from forests. Before collection of the fruits, the villagers clean the ground surrounding the tree and protect the trees.

The fruit becomes light black on ripening and is known as *Pandi*. The kernels of ripe fruit are large sized. Most of seeds are dried and sold in unprocessed form to local traders.

Chironji has short shelf life. The collection to marketing channel ranges from harvesting nuts, drying, washing, grinding nuts, sorting and grading, packaging and distribution. The marketing may range from local to regional and even international as some quantity is exported.

In view of the economic significance of *Buchanania lanzan* in the state, it was nationalized by the State Government in 2001 and brought under cooperative fold. However, it was denationalized again. Price fixation for different grades of guthly occurring in the state is not without problems. Traders usually fix price on the basis of percentage by floatation method. Only a small quantity of guthly is sold during the collection season to get better offers (Bhatnagar, 2003).



The processing of guthly is done in Amarwara where there are several small scale power driven mills.

Chironji is sold by different grades known as super quality (bold dana), best (double dana), medium etc. Grading criteria may be by size, quantity of broken nuts and freshness in taste.

Although, Chironji is an important NWFP which is commercially traded in the state very little is known about its collection, processing and marketing. Few studies by Bhatnagar and Bhausar (1988), Bhatnagar (1991) and Patnaik (2001) have been done over a limited area. No detailed study has been undertaken on pricing system and grade standards used in markets, appropriate harvesting time,

processing methods, market analysis, price variations and distribution channels (Bhatnagar, 2003)

To find the method of decortification of seeds, processing and storage, visit to processing units at Amarwada and Chhindwara were undertaken. Out of a total number of 25 processing units, 5% were visited.

To find the kernel/seed coat ratio of different sized seeds, three replicates were collected from Harrai Range, East Chhindwara Division and Chapara range, North Seoni Forest Division. The seeds were weighed and counted, thereafter kernels were extracted to find the kernel: seed coat-ratio in different sites. Table 4 gives the kernel seed coat ratio as 1:3

Table 4 - Processing for *Buchanania lanzan* seeds

<i>S. No.</i>	<i>Sample</i>	<i>R1</i>	<i>R2</i>	<i>R3</i>	<i>Average</i>
1.	Wt. of seeds at collection time (in gms)	100	100	100	100
2.	No. of seeds	384	380	382	382
3.	Wt. of kernel (Chironji) (in gms)	25	28.2	24.2	25.7
4.	Wt. of shell gms	75	71.8	75.8	75.3

Since the kernel has essential oil, it is prone to spoil on storage. It is best stored in its seed coat. Decortification of seeds should be done perhaps when there is requirement so that kernels remain fresh, white in color and taste good. It is best if it is vacuum packed.

5. *Terminalia belerica* (Baheda)

Introduction

It is a large tree with *buttresses leaves* large, long clustered near branch ends, flowers small, pale green, bad smelling fruits, 2-3 cm long, ovoid, brownish, densely covered with hairs. The tree occurs in forest areas.

General uses

Wood is used for making boards, small crafts, boxes, etc., Kernel oil for manufacturing of cheap soaps. Fruits called belliric myrobalan, used for tanning; ripe fruits are used as an astringent in combination with chebulic myrobalan, half ripe fruit used as purgative due to presence of an oil having properties similar to castor oil.



Medicinal uses

Oil is used for rheumatic swellings, pulp in ophthalmia, bark in anaemia and leucoderma, fruits for vitiated conditions of *Kapha* and *Vata*, bronchitis, pharyngitis, insomnia, dropsy, dyspepsia, flatulence, vomiting, haemorrhages, ophthalmopathy, stragury, splenomegaly, cephalagia, skin diseases, fevers, ulcers and general debility. Mature and dry fruits are used for constipation, diarrhoea and dysentery. The seed oil is useful in greyness of hair, helps in lowering cholesterol and blood pressure and paste is applied on conjunctivitis.

Three replicates were collected from Kundam, Jabalpur division. They were weighed and dried in sun till constant weight. The driage percent was 47.8%.

Table 5 - Driage percent in Baheda

<i>S.No.</i>	<i>Sample</i>	<i>R₁</i>	<i>R₂</i>	<i>R₃</i>	<i>Average</i>
1.	Green wt.(gms)	1000	1000	1000	1000
2.	No. of fruits	79	81	84	81
3.	Dry wt. (gms)	520	518	528	522
4.	Driage percentage	48%	48%	47%	47.8%

All material should be kept in *gunny* bags. Before storage inspect the dried fruits and remove the spoilt ones/or those which have not been dried properly.

There should be proper source of natural light/light in the godown. Material should be stacked two inches away from wall/roof. There should be no cracks or crevices in the floor of the godown.

6. *Woodfordia fruticosa* (Dhawai)

Introduction

A much branched shrub, bark pale brown, peeling off in fibres, young parts with small black glands. Flowers in axillary clusters on slender pedicles; rarely solitary.

General uses

Flowers, twigs and leaves are used for dyeing. Wood is used for making agricultural implements and is a source of fuel also.

Medicinal uses

Dried fruit and flowers are used in bowel complaints, haemorrhages, menorrhagia and seminal weakness. Flowers are useful in vitiated conditions of *Kapha and pitta*, leprosy, skin diseases, burning sensation, haemoptysis, erysipelas, diarrhoea, dysentery, foul ulcer, diabetes, bilious fever, hepatopathy and verminosis and juice is used for headache. Commercially available drug consists of dried fruits, flowers, buds and broken pieces of inflorescences.



Three replicates of samples weighing 170 gms each were weighed and dried in semi shade for 2 days. The dryage percent was 68.7%.

Table 6 - Dryage percent in Dhawai flowers

<i>S.No.</i>	<i>Sample</i>	<i>R1</i>	<i>R2</i>	<i>R3</i>	<i>Average</i>
1.	Green wt. (in gms)	170	170	170	170
2.	No. of days dried	2	2	2	2
3.	Dry wt. (in gms)	54.4	52.5	52.8	53.23
4.	Dryage percent				68.7%

7. *Butea monosperma* (Palash)

Introduction

It is a large deciduous tree with profuse bright orange red flowers. It is also known as "flame of the forest."

Medicinal uses

Seeds are anthelmintic. Decoction of seed powder is given for removing stones from kidney and gall bladder. Leaves are astringent and tonic. Juice or paste made from the leaves is applied on skin to control pimples and skin diseases. Bark powder of the tree mixed with dried ginger is beneficial in snake bite.

Samples were collected from SFRI campus, weighed into three replicates, initial weight taken and dried for 3 days. The dryage percent was 79.27.



The flowers are more sturdy than Dhawai and need to be packed in jute bags and should be stored in a clean dry go down free from insects, rodents etc.

Table 6 - Dryage percent in Dhawai flowers

<i>S.No.</i>	<i>Sample</i>	<i>R1</i>	<i>R2</i>	<i>R3</i>	<i>Average</i>
1.	Green wt .of (gms)	900	900	900	900
2.	No. of days dried	3	3	3	3
3.	Dry wt. (gms)	188	186	185.7	186.56
4.	Moisture content on green wt.				82.95
5.	Moisture content on drying				6.0
6.	Dryage percent				79.27%

8. *Madhuca latifolia* (Mahua)

Introduction

Tree upto 8 m tall, bark brown, leaves elliptic or oblong-elliptic, on rusty tomentose, pedicels clustered at the end of leafless branches. Mahua has an important role in rural economy apart from meeting food requirement it contributes to seasonal income. It has cultural and religious value.

General uses

The flowers are edible and collected by rural population for use as edible food and for brewing alcohol. Seeds yield edible oil.

Medicinal uses

Bark, leaves, flowers and seeds constitute the drug. Flower used in cough and bronchitis.



Two samples with three replicates each were taken and dried for 2-5 days

Table 8 - Driage percent in mahua

<i>S. No.</i>	<i>Sample</i>	<i>Average</i>	
		<i>Bharwari</i>	<i>Kanuva</i>
1.	Green wt. (in gms)	1000	1000
2.	No. of days dried	5	2
3.	After drying (in gms)	144.9	305
4.	Moisture content on dry wt.	-	32.57%
5.	Driage percent	85.5%	69.5%

9. *Andrographis paniculata* (Kalmegh)

Introduction

Andrographis paniculata is a small erect bitter annual herb belonging to the family of Acanthaceae. It is found wild and also as annual growth in deciduous forests. It is also found occurring in drier areas and under trees and bushes. Its local name is Kalmegh or kadu chiraita. It is used by rural communities for medicinal purposes. In Madhya Pradesh, it is commonly found in and around forests.

It is small erect, branched herbaceous to semi woody annual with the shoot portion lying down to the ground level, growing 30-70 cms or higher with sharply four angled four winged jointed stem and opposite or cross armed four sided spreading branches, bearing simple short petioled, opposite, lanceolate, entire glabrous leaves narrowed at both ends, from 2.5 to 7.5 cms long and about 12 mm wide.

Uses

The entire plant is used for medicinal purposes. It is known as a febrifuge, alternative and bitter tonic and is often used as a substitute for Chiraita. Decoction of whole plant is used by tribals in malaria.

The plant is harvested when it starts flowering and fruiting. The harvesting of leaves requires special attention to get maximum litter content. The entire plant is cut with sharp sickle and tied into bundles. These bundles are hung or spread out in light sun for drying. The process of drying may take a few days. It can also be dried using solar dryer.



Driage percent

An experiment was undertaken for estimating driage percent of Kalmegh. The plant was collected from South Seoni Division after flowering. Initial green weight was taken on site and three replicates of samples were collected. Thereafter, the whole plant was tied in a bunch and dried. Initial moisture content and moisture content on drying was calculated. Table 9 gives weight of dried plants. The driage was 65.37 percent.

Table 9. Driage in *Andrographis paniculata* (Kalmegh)

<i>S. No.</i>	<i>Sample</i>	<i>Average</i>
1.	Green weight (in gms)	750
2.	Initial moisture content	75.0%
3.	No. of days dried	3
4.	Dried wt (in gms)	259.67
5.	Moisture content on drying	10.0%
6.	Driage percent	65.37%

Leaves are prone to spillage and contamination. If not dried properly they turn black. They occupy more place. They need to be cut into pieces to facilitate packing. Kalmegh could be packed in woven sacks with SD linner.

10. *Asparagus racemosus* (Satawar)

A scandent climber, distributed throughout tropical Asia, Africa, and Australia. It is common in India, ascending up to an altitude of 4,000 ft. in the Himalayas. Several medicinal properties are attributed to the root. It is said to be tonic and diuretic and useful as a galactagogue. A mixture of honey and fresh root juice is given as a demulcent in dyspepsia (CSIR, 1948).

For standardising drying techniques, sample was divided into three treatments, fresh long tubers were peeled, broken and inner thread was removed. The green weight was again taken and then dried for five days.



Table - 10: Driage percent of *Asparagus racemosus*

<i>Replication based</i>						
<i>S. No.</i>	<i>Treatment</i>	<i>Fresh Weight (gm)</i>	<i>Days</i>	<i>Mean dry wt. (gms)</i>	<i>SD</i>	<i>Driage %</i>
1.	Sun drying	1000	5	192	5	80.8
2.	Oven drying	1000	5	191.33	8.08	80.86
3.	Solar drying	1000	5	190	10	81

T₁- Sun drying

T₂- Oven drying

T₃- Solar drying

The mean driage was between 80-81% tubers are prone to microbial contamination due to presence of moisture. They can be stored in woven sacks with LD liner.

11. *Plumbago zeylanica* (Chitrak)

Introduction

Plumbago zeylanica (Chitrak) is a perennial sub scandent shrub found in peninsular India and West Bengal. It is cultivated in gardens throughout India. In Madhya Pradesh, Jabalpur, Sagar, Chhindwara and Indore districts are rich in it. Roots of chitrak mature for harvesting after one year of planting. Cylindrical red and brown roots have a different compound which is used as a medicine.



Uses

The roots of *Plumbago zeylanica* are used as an appetizer for the preparation of several homeopathic and Ayurvedic medicines like Plumbago, Chitrakadibati, etc. said to constitute the original indigenous drug known to Ayurvedic physicians. The root bark of *Plumbago zeylanica* contains plumbagin free glucose, fructose, protease and invertase. Root of chitrak is useful in stimulating digestive process.

Collection

Harvesting of Chitrak is done in December and January. The root is dug up on all sides and soil is removed. The roots are then extracted carefully and are washed 2-3 times in water to remove soil and other material.

Processing technique

An experiment was undertaken for processing and estimating driage percent, tubers were collected from Khandari nala, near SFRI nursery. Initial fresh weight was taken. Three replicate samples of mature tubers weighting 500 gms each were used for processing in this treatment. Roots of Chitrak were cut and graded in accordance to thickness.

Table - 11: Driage percent in *Plumbago zeylanica*

<i>S. No.</i>	<i>Sample</i>	<i>Fresh wt. of root (gms)</i>	<i>Average tuber length</i>	<i>Initial moisture content (m.m.)</i>	<i>No. of days dried</i>	<i>Moisture content after drying</i>	<i>Dry wt. (gms)</i>	<i>Driage percent %</i>
1.	R ₁	500	32.3	60.13	8	17.52	374	25.2
2.	R ₂	500	26.2	60.13	8	17.52	345	31
3.	R ₃	500	29.5	60.13	8	15.02	359	28.2

Kalmegh could be packed in woven sacks with *SD* liner. Dry roots of Chitrak can be stored in the polythene bags.

12. *Tinospora cordifolia* (Giloy)

Introduction

Tinospora cordifolia commonly known as giloy is a large, glabrous climbing shrub found throughout India. In Sanskrit it is known as *Amrita*, *guluchi* and in Hindi as *giloe*, *gulbel*, *gurcha* etc.

The stems have medicinal properties. They are succulent with long filiform fleshy aerial roots from the branches. Bark grey brown or creamy white, warty; leaves membranous, cordate with a broad sinus; flowers small, yellow or greenish yellow, appearing when the plant is leafless, in axillary and terminal racemose panicles. (CSIR, 1952).



Uses

Tinospora cordifolia is mentioned in Ayurvedic literature as a constituent of several compound preparations, used in general debility, dyspepsia, fever and urinary diseases. Anti viral properties against *Ranikhet* disease in poultry have also been ascribed to this climber. The bitter principles in the drug show anti periodic, antispasmodic, anti inflammatory and pyretic properties.

The time for harvesting is when the leaves turn yellow and start falling. The stem is cut with sharp knife/ sickle. The remaining leaves are removed and bark is peeled. The long stems are cleaned and cut into 2 inch pieces; if the stem is young then peeling is not required.

Processing and driage

An experiment was undertaken for processing of giloy and for estimating driage percent. The stems of giloy were collected from SFRI campus Three replicate samples weighing 1000 gms each were cut into 4 inch pieces and dried for 23 days in shade. Driage percent was estimated by weight loss on drying. Table 12 gives the driage per cent as 52%. A kind of starch (*Giloy ka sat* or *guduchi satva*) can also be prepared for starch, the stems are peeled and soaked in 10 times the amount of water for 10 hours. When soft they are rubbed in water and strained in a muslin cloth. The starch settles in the bottom and is dried in the sun. It becomes the Arrowroot powder. In one kg giloy one can get upto 10-20 gms of starch.

Giloy is sorted and graded according to thickness of stems and stored in bags free from moisture.

Table - 10: Driage percent in Giloy

<i>S. No.</i>	<i>Sample</i>	<i>Green wt. (in gms.)</i>	<i>No. of days dried in shade</i>	<i>Dry wt.</i>	<i>Driage %</i>
1	R ₁	1000	23	582	52.0
2	R ₂	1000	23	581	52.0
3	R ₃	1000	23	583	52.0

13. *Phyllanthus niruri* (Bhui amla)

Phyllanthus niruri L. belongs to the family *Euphorbiaceae*, commonly known as bhuiamla. It is an annual herb of 30-60 cm height, quite glabrous, stem often branched at the base. Most common in Central and Southern India extending to Sri Lanka. The herb is bitter in taste, and is reported to possess astringent, deobstruent, stomachic, diuretic, febrifugal and antiseptic properties. (CSIR, 2005).

It is a perfect example of a highly beneficial medicinal plant which deserves much more research due to its increasing popularity in many continents as a herbal remedy for different diseases and ailments. The plant is employed by standard infusion or decoction of the whole plant or its aerial parts in water against diabetes, malaria, dysentery, fever, flu, tumors, jaundice, as analgesic, digestive, laxative, stomachic and tonic and also used for kidney stone elimination and in other urinary tract infections as a result of its various chemical constituents (Obodozie, 2000). The leaves are rich in potassium (0.83%, fresh basis) which is considered responsible for their powerful diuretic effect (Krishnamurti and Seshadri, 1946). In the traditional method, plant is uprooted and dried in the sun.



In the experiment, three different treatments were used for drying-

T₁ - Sun drying.

T₂ - Solar drying.

T₃ - Shade drying under room condition.

For standardizing drying techniques, samples were divided into three treatments with three replications each. Green weight of each sample was recorded and weighing of replicates was done daily. The samples were dried for 2-3 days under sun light and solar dryer and for 4-5 days under shade drying. The dryage percent was calculated.

Result

The driage per cent is influenced by moisture content of particular species and treatments. Driage percentage and statistical analysis (Mean, SD, variance and SE) of *Phyllanthus niruri* L. is given in Table 13

Table 13: Driage percent of *Phyllanthus niruri* L.

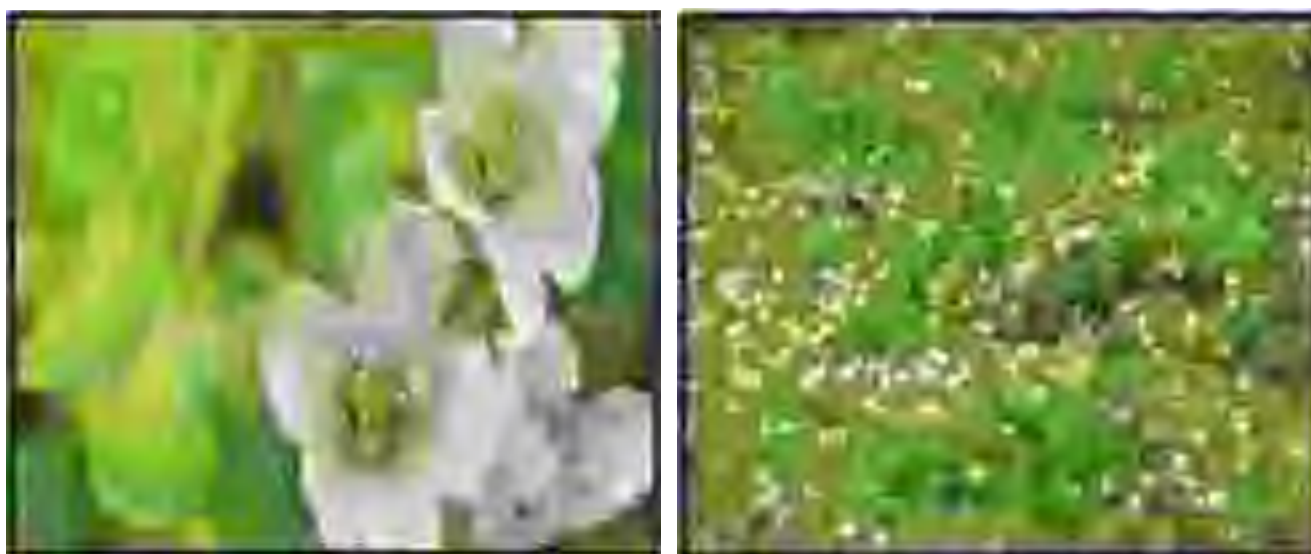
<i>S.No.</i>	<i>Treatment</i>	<i>Fresh weight (gms)</i>	<i>No. of days of drying</i>	<i>Replication based</i>				<i>Driage%</i>
				<i>Mean dry weight (gms.)</i>	<i>SD</i>	<i>variance</i>	<i>SE</i>	
1.	Sun drying	200	3	91.67	3.21	10.33	1.86	54.5
2.	Solar drying	200	3	85.67	8.96	80.33	5.17	57.5
3.	Shade drying under room condition.	200	4	104.00	4.36	19	2.52	48

The first treatment (Sun drying) and second treatment (Solar drying) had taken less number of days in comparison to the third treatment (Shade drying), due to less temperature in the third treatment.

The driage percent of *Phyllanthus niruri* L. under sun, solar and shade drying treatments was recorded as 54.5 %, 57.5% and 48%, respectively with mean value ranging from 85.67 gm in T₂ to 104.0 in T₃ SD (3.21-8.96), Variance (10.33- 80.33) and SE (1.86-5.17) as given in Table 13

14. *Bacopa monnieri* (Brahmi)

Bacopa monnieri (L.) Pennell belonging to *Scrophulariaceae* family is commonly known as *brahmi*. It is a small, creeping, juicy, succulent, glabrous annual herb rooting at the nodes with numerous ascending branches, commonly found growing in marshy places, throughout India, ascending to an altitude of 1,320 m. It can also be grown in damp areas, and can be propagated vegetatively or by seeds. It is astringent, bitter and is reported to improve intellect. It is used in indigenous system of medicine for the treatment of asthma, hoarseness, insanity, epilepsy and as a cardio and potent nerve tonic. The drug forms an important ingredient of a number of Ayurvedic preparations, such as *Brahmighritam*, *Brahmirasayanam*, etc. The herb contains the alkaloid brahmine, herpestine, and a mixture of three bases. Brahmine is highly toxic.



Analysis of the leaves and stalks gave: moisture, 88.4%; protein, 2.1%; fat, 0.6%; etc. (CSIR, 1988). To standardise drying techniques, three different treatments were used

T₁ - Sun drying

T₂ - Solar drying

T₃ - Shade drying under room condition

Samples were divided into three treatments with three replications each. Green weight of each species was recorded and weighing of replicates was followed daily. The samples were dried for 3 days in sun and solar dryer, while for 5 days in shade drying. The drying percent was calculated as given in methodology.

Table 14: Driage percent of *Phyllanthus niruri* L.

<i>Replication based</i>								
<i>S.No.</i>	<i>Treatment</i>	<i>Fresh weight (gm)</i>	<i>Days</i>	<i>Mean dry weight (gm)</i>	<i>SD</i>	<i>Variance</i>	<i>SE</i>	<i>Driage %</i>
1.	Sun drying	300	3	33.67	2.31	5.33	1.33	88.7
2.	Solar drying	300	3	32.33	1.15	1.33	0.67	89.3
3.	Shade drying under room condition.	300	5	33.67	2.13	5.33	1.33	88.7

The driage percentage of *Bacopa monnieri* (L.) Pennell under sun, solar and shade drying treatments was recorded as 88.7 %, 89.3% and 88.7%, respectively with mean value range (32.33-33.67), SD (1.15-2.31), Variance (1.15-5.33) and SE (0.67-1.33) as given in Table 14

15. *Gloriosa superba* L. (Kalihari)

Gloriosa superba is a branched herbaceous climber common in low forests throughout India and in Andaman Islands. Stems slender, annual, upto 20 ft. long, arising from a perennial, fleshy, tuberous rhizome. It flowers during the rainy season and is commonly cultivated in gardens. It is propagated by divisions of rhizomes planted before the rains in light rich soil with good drainage (CSIR, 1956). The tubers are regarded as tonic, stomachic and anthelmintic when taken in doses of 5-10 grams. The drug is reported to be used for a variety of medicinal purposes.

The tubers were harvested after rains, washed and cleaned to remove adhering matter and cut into small pieces and dried.



Green weight was taken and then samples were dried under three treatments viz. T₁(Oven drying), T₂(Sun drying) and T₃(Shade drying) as given below. On the basis of size of pieces each treatments was subdivided into 3 sub treatments

T₁ : <1 inch

T₂ : 1-2 inch

T₃ : 2-3 inch

Table – 15: Driage percent of *Gloriosa superba* L.

S. No.	Treatments	Fresh weight (gms)	Days	Sub treatments	Mean dry wt.	SD	CV	Driage %
1.	Oven drying	500	5	T ₁	100.0	0.61	6.1	80.0
				T ₂	90.0	1.6	18.2	82.0
				T ₃	70.8	2.3	30.1	84.0

2.	Sun drying	500	6	T ₁	50.3	0.6	108.8	89.0
				T ₂	80.7	1.5	17.6	82.6
				T ₃	70.0	4.0	57.1	86.0
3.	Shade drying	500	6	T ₁	70.7	2.1	27.2	84.0
				T ₂	80.7	2.9	33.3	82.6
				T ₃	110.3	6.8	60.1	77.4

Maximum driage percentage was reported from samples (<1 inch size) in sun temperature drying. The driage percent in oven drying treatment varied from 80% to 84%. In sun drying the driage percent varied from 82.6% to 89% while in shade drying driage varied from 77.4% to 84%. Grading of rhizomes will fetch better prices to local community.

16. *Gymnema sylvestre* (Gurmar)

Gymnema sylvestre (Retz.) R.Br. belongs to family Asclepiadaceae, commonly known as *gurmar*. It is a large, woody, much branched climber with pubescent young parts; leaves simple, opposite, elliptic or ovate, base rounded or cordate; flowers small, yellow in umbellate cymes; fruits slender, follicles upto 7.5 cm long. Most commonly distributed in Deccan peninsula, extending to parts of Northern and Western India, mainly in dry forests upto 600 m. (CSIR, 1956).

An aqueous extract of the leaves contains anti-sweet principles, saponins gymnemic acid III, IV, V, VIII, IX and additionally XV-VVIII with anti-sweet property. The plant is bitter, astringent, anti-inflammatory, anodyne, digestive and stimulant. Extracts are useful as pharmaceuticals, used in inflammations, constipation, jaundice, conjunctivitis and leucoderma, etc. The fresh leaves have a remarkable property of paralyzing the sense of taste for sweet and bitter substances for some time (Prajapati *et al.*, 2003).



The traditional method of harvesting gurmar by cutting the climber along with stems has depleted the resource base. Unsustainable harvesting is likely to affect supply in future. It has been observed that while industries require only leaves for the gymnemic extract, stems are included by rural communities which makes it different for processing. The industries have to get sorting done at factory.

The experiment was divided into three treatments viz., (T₁) sun, (T₂) solar and (T₃) shade drying, fresh weight of leaves taken and dried.

Table - 16: Driage percent of *Gymnema sylvestre* (Retz.) R. Br.

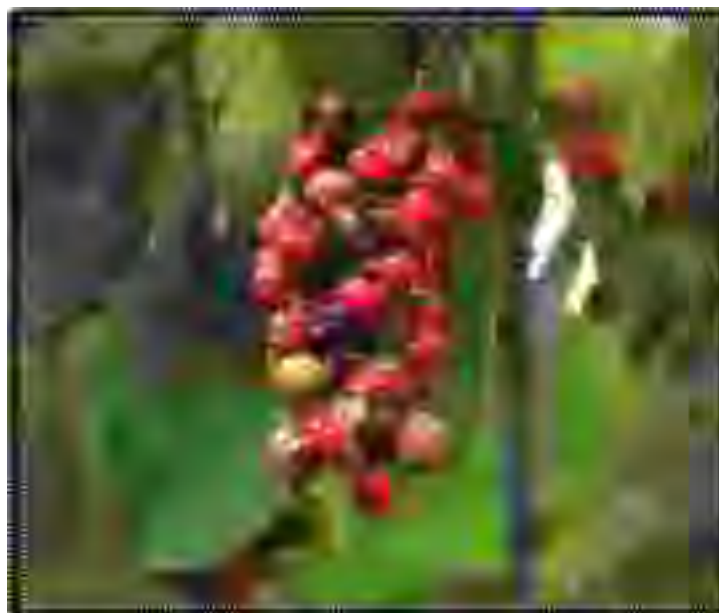
Replication based								
S.No.	Treatment	Fresh weight (gms)	Days	Mean dry wt. (gms)	SD	Variance	SE	Driage %
1.	Sun drying	250	2	95	1.00	1	0.58	62
2.	Solar drying	250	2	93	2.65	7	1.53	62.8
3.	Shade drying under room condition.	250	4	93	2.65	7	1.53	62.8

The driage percentage of *Gymnema sylvestre* (Retz.) R. Br. under sun, solar and shade drying treatments were recorded 62%, 62.8% and 62.8% respectively with mean value range (93-95), SD (1.00-2.65), variance (1-7) and SE (0.58-1.53) as given in Table 16

17. *Celastrus paniculatus* (Malkangni)

Celastrus paniculatus is found in wild and its family is *Celastraceae*. A large climbing shrub with yellow fruits, common all over the hilly parts of the country upto an altitude of 4,000 ft. The seeds are brown and are covered by a scarlet aril.

The leaves are emmenagogue and the leaf sap is used as an antidote for opium poisoning. The bark is abortifacient. The seeds are bitter, laxative, emetic and tonic. They are used as stimulant and diaphoretic in rheumatism, gout and various fevers. The oil obtained from the seeds is said to be deep reddish-yellow and it becomes thick and honey-like on keeping. It possesses medicinal properties. Distillation of the seeds yields black empyreumatic oil, oleum nigrum which has powerful stimulant properties. Its action is followed in a few hours by free diaphoresis unattended by exhaustion. The crushed seeds on extraction with petroleum ether, yield brownish oil with an unpleasant taste. (CSIR, 1950).



Method - The villagers generally collect mixed lot of raw and ripe fruits. For the experiment only ripe fruits were collected. The seed of *Celastrus paniculatus* Linn. was used as drying material for applied treatments. This experiment was done in the months of September-October.

For standardization of drying technique, sample was divided into two treatments with five replications each.

T₁ - Sun drying

T₂ - Shade drying

Green weight of species was recorded and weightment of replicates was followed daily. The sample was dried for 9 days under sunlight and 18 days under shade drying. The driage percent as per methodology:

The driage percent is influenced by moisture content of particular species and treatments. Driage

percent and analysis (Mean, SD, Variance and SE) of *Celastrus paniculatus* Linn. is given Table 17

Table 17: Driage percent of *Celastrus paniculatus*

S. N	Treatments	Fresh wt. gms.	Initial moisture content (in per cent)	Days	Mean wt. (gms)	SD	CV	Moisture content after driage (in per cent)	Driage %
1.	Sun drying	100	46.19	9	83.4	0.5	0.6	12	16.6
2.	Shade drying	100	46.19	18	81.4	0.5	0.7	16	18.6

The driage percent of *Celastrus paniculatus* Linn. under sun and shade drying treatments were recorded as 16.6 per cent and 18.6 per cent respectively with mean value range (81.4-83.4), SD- (0.5), CV-(0.6-0.7).

18. *Mucano pruriens* (Kewanch)

Mucano pruriens is a herbaceous coiling annual found almost all over India. The plant is found in bushes, hedges, ravines and degraded forests throughout plains. It is useful as a manure and cover crop. It is also grown for its pods and young leaves, which are used as vegetable and as fodder. The pods of *M. pruriens* also known as *kewanch* have been used earlier as famine food after repeated boiling and throwing away water.

The roots are tonic, stimulant, diuretic, purgative and emmenagogue. They are used for diseases of the nervous system, kidney troubles and dropsy. (CSIR, 1962)

The pods of *M. pruriens* were plucked when ripe and peeled. They were used for driage experiment. Three different driage treatments with three replications were applied.

T₁ - Sun drying

T₂ - Solar drying

T₃ - Shade drying



Green weight of samples was taken and weighment of replicates done daily. The samples were dried for 8 days in sun, 7 days in solar drying and for 9 days under shade drying. Driage percent and analysis (mean, SD, Variance and SE of *Mucano pruriens* is given in Table 18

Table 18: Driage percent of *Mucano pruriens* seeds

S. No.	Treatment	Fresh weight (gm)	Days	Mean dry weight	SD	Variance	Driage %
1.	Sun drying	300	8	74	2.0	4.3	75
2.	Solar dryer	300	7	68	1	1	77.33
3.	Shade drying	300	9	116	1.53	2.33	61.22

T₁ (sun drying) took 8 days, minimum number of days 7 days was under T₂ (solar drying) and maximum under shade drying 9 days. The driage treatments under sun, solar and shade drying treatments were recorded 75, 77.3 and 61.2% respectively with mean weight range (68-116), SD, (1-2.0) Variance (11-4.3)

19. *Acorus calamus* Linn. (Bach)

Acorus calamus Linn belongs to Araceae family and is commonly known as sweet flag. It is a semi aquatic perennial herb with a creeping and much branched aromatic rhizome. Externally it is light brown or pinkish-brown, and is white spongy within. (CSIR, 1948).

It is a native of eastern countries and is indigenous to the marshes of the mountains of India. It is cultivated throughout India. It is plentiful in the marshy tracts of Kashmir, Sirmoor, Manipur and Naga hills. (Asolkar, *et.al.*, 1992).

Commercially it occurs in both peeled and unpeeled form. This perennial herb is common on the banks of streams. The sweet flag oil present in this plant is a unique source of oxygenated sesquiterpenes of great structure variety (Rohr, *et. al.*, 1979).

The plants are dug out, and the top are kept for next plantation. The rhizomes are dried in the sun, before they are marketed. The dry rhizomes contain 1.5-3.5% of a yellow aromatic volatile oil. It has a mellow odour resembling that of patchouli (*Pogostemon cablin*) (Kelkar, *et al.*, 1934). The rhizome of the plant has medicinal properties against bugs, moths, lice, emetic stomach in dyspepsia (Rai, *et al.*, 1999). The dried rhizome is a common bazaar medicine, and is generally used in form of an infusion. It is an aromatic bitter tonic and carminative, possesses emetic and anti- spasmodic properties and produces beneficial result in cases of chronic diarrhoea (CSIR, 1948).

The rhizome also possesses insecticidal properties and is useful against bed-bugs, moths, lice, etc. (Subramaniyam, 1942).



Method

The rhizome of *Acorus calamus* Linn. was used as a drying material for applied treatments. This experiment was put down in the month of June. Three different treatments used for drying :-

T₁ - Sun drying.

T₂ - Solar drying.

T₃ - Shade drying under room condition.

For standardizing drying techniques, sample was divided into three treatments with three replications each. Green weight of samples was recorded and weight of replicates was followed daily. The sample was dried for 3 days under sun light and solar dryer and, 4 days under shade drying. The driage percent was estimated.

Result

Driage percent and analysis (Mean, SD, Variance and SE) of *Acorus calamus* Linn. is given in Table 19.

Table - 19: Driage percent of *Acorus calamus* Linn.

Replication based								
S.No.	Treatment	Fresh weight (gm)	Days	Mean dry Wt. (gms)	SD	Variance	SE	Driage %
1.	Sun drying	300	3	92	2.12	4.50	0.95	69.33
2.	Solar drying	300	3	94.6	2.07	4.3	0.93	68.46
3.	Shade drying under room condition.	300	4	101.8	5.22	27.2	2.33	66.06

T₁ (Sun drying) and T₂ (Solar drying) took minimum number of days as compared to T₃ (shade drying). The driage percent of *Acorus calamus* Linn under sun, solar and shade drying treatments were recorded 69.33, 68.46 and 66.06 respectively with mean weight value range (92-101.8), SD (2.07-5.22), Variance (4.3-27.2) and SE (0.93-2.33).

20. *Eclipta alba* (Linn.) Hassk (Bhringraj)

Eclipta alba (Linn.) Hassk, belongs to family Asteraceae, commonly known as a Bhringraj, Bhagra and Mochkand, is a small branched annual herb with white flower heads inhabiting tropical and subtropical regions of the world. *Eclipta alba* (Linn.) Hassk has been traditionally used to check hair loss and stimulate hair growth. The extracted juice if taken internally and applied to the scalp blacken the hair (Chopra *et al.*,1955; Kritikar and Basu,1975).

It is a common weed in moist situation throughout India on the hills upto 6000 ft. The herb of this plant is used as tonic and deobstruent in hepatic and spleen enlargements and in skin disease (CSIR, 2003 Reprinted).The root of this plant is emetic and purgative. It is also useful part of plant, applied externally as antiseptic to ulcer and wounds in cattle. The shoot extract shows antibiotic activity against *Staphylococcus aureus* and *Escherichia coli* (Nadkarni, *et al.*1952).

The plant has been extensively studied for its hepato protective activity and a number of herbal preparations comprising *E. alba* are available for treatment of jaundice and viral hepatitis (Saraf, A.P.*et al.*,1991; Singh, *et al.*2001). The plant contains the phytoconstituents like wedelolactone and dimethyl wedelolactone as main active ingredient (Wagner, 1986).



Method

The whole plant of *Eclipta alba* (Linn.) Hassk was used as a drying material for applied treatments. Three different treatments were used for drying purpose:

T₁ - Sun drying.

T₂ - Solar drying.

T₃ - Shade drying under room condition.

For standardizing drying techniques sample was divided into three treatments with three replications each. Green weight of samples was recorded and weight of replicates was followed daily. The sample was dried for 2 days under sun light and solar dryer while 3 days under shade drying.

Result

The driage percent of medicinal plants was influenced by moisture content of particular species and treatments. Driage percent and statistical analysis (Mean, SD, variance and SE) of *Eclipta alba* (Linn.) Hassk. is given in Table 20

Table 20: Driage percent of *Eclipta alba* (Linn.) Hassk.

Replication based								
S.No	Treatment	Fresh Wt.(gm)	Days	Mean dry wt. (gms)	SD	Variance	SE	Driage %
1.	Sun drying	400	2	69.0	3.16	10.0	1.41	82.75
2.	Solar drying	400	2	66.2	1.79	3.2	0.80	83.50
3.	Shade drying under room condition.	400	3	77.8	1.48	2.2	0.66	80.55

T₁ (Sun drying) and T₂ (Solar drying) had taken minimum number of days in comparison to T₃ (Shade drying). The driage percent of *Eclipta alba* (Linn.) Hassk under sun, solar and shade drying treatments were recorded 82.75, 83.50 and 80.55 respectively. In statistical analysis the mean weight value ranged between (66.2- 77.8), SD (1.48-3.16), Variance (2.2-10.0) and SE (0.66-1.41) for *Eclipta alba* (Linn.) Hassk. under different driage treatments.

21. *Costus speciosus* (Keokand)

It is a plant with a tuberous rhizome, distributed throughout the country. It is 4-10 ft high with large lanceolate leaves about a foot long. The branches are red, flowers large (3-4 inch across) with white limbs and yellowish centres. It is often cultivated as an ornamental plant and also known as crepe ginger.

The plant thrives on rich moist soil under shade conditions. The rhizome is edible. It is rich in starch but compared to other tuberous foods the fibre content is high. The rhizome has purgative and tonic properties(CSIR, 1950).



Table - 16: Driage percent in *Costus speciosus*

Replication based								
S. No.	Treatment	Fresh weight (gm)	Days	Mean dry wt. (gms)	SD	Variance	SE	Driage %
1.	Sun drying	300	12	102	2.74	7.50	1.22	66.00
2.	Solar drying	300	12	107.2	2.59	6.70	1.16	64.26
3.	Shade drying under room condition	300	15	122.6	3.78	14.30	1.69	59.13

T₁ (Sun drying) and T₂ (solar drying) took 12 days of drying and driage percent ranged between 64.26 to 66.0 percent, SD (2.74 to 3.78), Variance (6.70-14.30) and SE (1.16-1.69)
T₃ (Shade drying) took 15 days.

22. *Lepidium sativum* (Chandrasur)

A small herbaceous, glabrous annual, 15-45 cm high cultivated as salad plant. Garden cress thrives on any good light soil, but does best on moist loam. It can be grown at all elevations, all the year round, but the best crop is obtained in the winter season. Garden cress leaves are consumed raw in salads. It has medicinal properties and is used asthma, coughs and piles. The seeds contain an alkaloid (0.19%) glurcotropaelin, sinapin, sinapic acid and uric acid. (CSIR,1962)



For standardising drying techniques sample was divided into three treatments with three replications in each. Green weight of the samples was recorded and weighing of replicates done periodically.

Table 22. gives the driage percent and analysis of the experiment. T₁(sun drying) and T₂(solar drying) took 2 days for drying with 9.23 driage percent. Shade drying treatment T₃ took 4 days. The driage percent ranged between 4.56-9.33 percent.

Table 22: Driage percent of *Lepidium sativum*

Replication based							
S. No.	Treatment	Fresh Weight (gms)	Days	Mean dry wt. (gms)	SD	Variance	Driage%
1.	Sun drying	300	2	272.3	2.52	6.33	9.23
2.	Solar drying	300	2	272	2.65	7	9.33
3.	Shade drying under room condition	300	4	286.3	1.53	2.33	4.56

23. *Curcuma angustifolia* (Tikhur)

This species occurs in the hilly tracks of Madhya Pradesh, Maharashtra, Tamilnadu, Jharkhand and some of the lower Himalayan ranges. The tubers also known as Tikhur contain starch which is used as a substitute for true arrowroot powder.

The plant grows wild and is commonly found in moist deciduous Sal and mixed forest. It is found in moist and cool situations at altitudes about 1500 ft, and is cultivated to a small extent. The tubers are planted in autumn and watered occasionally during the dry period. They are harvested in January. Over exploitation has led to depletion of Tikhur in natural forests(CSIR, 1950).

The fresh rhizomes of Tikhur are used for the preparation of starchy flour, which has medicinal value and is effective for many diseases.

In the traditional method, processing of fresh rhizomes is done by washing in water, peeling and cutting rhizome into small pieces or rubbing on stone or by using sieve. Water is added and tikhur is rubbed by hands in water in a bucket or vessel. It is then sieved through muslin cloth. The filtered solution of tikhur powder is collected and left overnight in the vessel to allow starch particles to settle. The starch settled in the bottom and the water was thrown away. This process was replicated six times till the bitterness in taste was gone.

In this experiment, tubers were ground using wet grinder and tikhur starch was dried in trays.



24. *Cassia fistula* (Amaltas Phali)

The golden shower tree is a medium-sized tree, growing to 10-20 m (33-66 ft) tall with fast growth. The leaves are deciduous, 15-60 cm (6-24 in) long, pinnate with 3-8 pairs of leaflets, each leaflet 7-21 cm (3-8 inches) long and 4-9 cm (1.5-3.5 in) broad. The flowers are produced in pendulous racemes 20-40 cm (8-15 in) long, each flower 4-7 cm diameter with five yellow petals of equal size and shape. The fruit is a legume, 30-60 cm (12-23 in) long and 1.5-2.5 cm (0.5-1 in) broad, with a pungent odour and containing several seeds. The seeds are poisonous. The tree has strong and very durable wood, and has been used to construct “Ahala Kanuwa”, a place at Admas Peak, Sri Lanka, which is made of *Cassia fistula* (“ahala”, “Ehela” or aehaela in sinhala) heartwood (CSIR, 1950).



Method

The seed of *Cassia fistula* Linn. was used drying material for applied treatments. This experiment was done in the month of April. Two treatments used for drying-:

1. Sun drying
2. Shade drying under room condition

For standardization drying techniques. Sample was divided into two treatments with three replications each. Green weight of species was recorded and weighment of replicates was followed daily. The sample was dried for 2-3 days under sunlight and 3-4 days under shade drying. The driage percent is estimated as under:

Results

The driage percent is influenced by moisture content of particular species and treatments. Driage percentage and analysis (Mean, SD, Variance and SE) of *Cassia fistula* Linn. is given Table - 23.

Table 23: Driage percent of Cassia fistula

S. No.	Treatments	Fresh wt. gms	Days	Mean wt.	SD	CV	Driage %
1.	Sun drying	80.0	8.0	59.6	1.3	2.3	25.5
2.	Shade drying	80.0	9.0	62.0	1.0	1.6	22.5

T₁ – Sun driage

T₂ – Shade driage

The driage percent of *Cassia fistula* Linn. under sun and shade drying treatments were recorded. 25.5, 22.5 respectively with mean value range (59.6-62.0), SD - (1.3-1.0), CV- (2.3-1.6)

25. *Curcuma caesia* (Kali Haldi)

A perennial herb, 2-3 ft. high with a short stem and tufted leaves. Fresh tubers are pale yellow aromatic, and are used as a cosmetic. They are also used externally for sprains and bruises. (CSIR, 1950)



Table – 24: Driage percentage in *Curcuma caesia*

S. No.	Treatment	Sub treatments	Fresh weight (gums)	Days	Mean wt.	SD	CV	Driage %
1.	T ₁ Sun drying	T ₁ (Big Rhizome)	100	19	39.4	1.1	2.9	60.0
		T ₁ (2) (Small Rhizome)	100	19	40.0	2.3	5.9	60.0
		T ₁ (3) (Tubers)	100	19	26.0	2.9	11.2	74.0
2.	T ₂ Shade drying	T ₂ (1) (1(Big Rhizome)	100	31	44.2	2.3	5.2	55.0
		T ₂ (2) (Small Rhizome)	100	31	44.8	1.3	2.9	55.2
		T ₂ (3) (Tubers)	100	31	41.0	3.7	9.0	59.0

The rhizomes were washed thoroughly. They were boiled for half an hour until foam oozed with strong odour. The rhizomes are taken out, colour changed from blue to brown. They were then dried for 19 days.

Two treatments T1 (Sun drying) and T2 (Shade drying in room temperature) were applied on kali haldi samples which were divided into three sub treatments segregated in three sizes (big rhizome, small rhizome and tubers). Initial weight of samples taken was 100 gms. Driage varied between 39.4 to 44.8% for all treatments. Driage per cent varied between 55.0 to 60 % except for sundried tubers T1 (3) which revealed maximum driage percentage 74.0%. No significant difference was observed between big and small sized rhizome driage.

26. *Azadirachta indica* (Neem)

This is a medium-sized tree, with a clear bole of 10-25, and a girth of 6-8. Although described as evergreen, in drier areas it becomes deciduous. Its bark is moderately thick with longitudinal or oblique furrows on the outer surface. It is a drark-grey outside and reddish inside. The flowers 140 appear from March-May and the fruits ripen during June-August. They are greenish yellow when ripe, and usually contain only one seed.

Almost every part of the tree is bitter and has found application in indigenous medicine. The seed oil (margosa oil) is acird, yellow bitter in taste, and has a disagreeable garlic-like odour. It is also used in skin diseases such as scrofula, indolent ulcers, and sores, and ringworms. It is also applied in cases of rheumatism as a liniment.

The seeds are reported to contain up to 45% of oil. The oil is usually prepared in *ghanis* (Wooden oil mills) for local use, either as medicine or as an illuminant. However, while burning, it smokes badly. If seeds are heated before crushing, the odour becomes intolerable. Considerable quantities of the oil are used for the preparation of cheap washing soap. Medicated soaps with the odious of neem are found in the market.



The oil cake is regarded as a useful fertilizer matter, 6-8-7; organic matter, 84-89; inorganic matter, 1.69-5.07; salts, 3-9; P_2O_5 , 0.68-1.4%.s.

Table 25 Processing and driage percent of *Azadirachta indica*

S. No.	Samples	R1	R2	R3	R4	Av. gm
1.	Green weight	300	300	300	300	300
2.	No. of days dried	7	7	7	7	7
3.	Dried weight	75.6	74.4	70.4	80.7	75.2

27. *Madhuca latifolia* (Mahua gulli)

M. talics latifolia is found in mixed deciduous forests, usually of a somewhat dry type, often growing on rocky and sandy soil and thriving on the Deccan trap. It is common throughout Central India, Maharashtra and Andhra Pradesh. It is also common in the drier type of Sal forests in Madhya Pradesh.

A large evergreen tree with a dense spreading crown found in South India. Bark grey to dark brown, scaly, leaves clustered near ends of branches. Linear – lancolate, 7.5-12.5 cm x 2.5-4.5 cm., tapering towards base, glabrous when mature; flowers in dense clusters near ends of branches, many, small; calyx rusty pubescent; corolla tubular, fleshy, pale yellow, c. 1.5 cm long, aromatic, caduceous; berries ovoid, c. 5 mm long, yellow, when ripe; seeds usually 1-2, compressed, yellow, shining.

It is valuable for its seed which yield oil, known in commerce as Mahua Butter, Illepe Butter or Bassia Fat.

The fruits ripen in May-June, when they fall from the tree or are dropped by vigorous shaking of the branches. The season for collecting the seeds is short and in the absence of organized harvesting a considerable portion of the crop is lost during the monsoon.

The seeds are separated from the fruit wall by pressing and then dried and shelled to get the kernel (c. 70% of the weight of seed). The kernels constitute the mahua seed of commerce.

Mahua seeds available in the trade contain 5-12% moisture and 2-5% refraction. Seeds containing more than 7-8% moisture are liable to fungus attack when stored. Analysis of seeds kernel gave the following values: fatty oil, 51.1; fibre, 1.03 and ash, 2.7 (Wehmer, II, 92.)

calyx rusty pubescent:

Table 26 : Processing and driage percent of *Madhuca latifolia*

S. No.	Samples	R1 (gm)	R2 (gm)	R3 (gm)	R4 (gm)	Av. Gm (gm)
1.	Green weight	300	300	300	300	300
2.	No. of days dried	7	7	7	7	7
3.	Dried weight	128.2	136.7	136.3	138.7	135
4.	Seed coat/shell weight	57.0	52.6	46.9	42.1	49.6
5.	Moisture content					6.32

Driage percent : 55.0

28. *E. tsjeriam cottam* (Baibirang)

A large scandent shrub with slender branches and elliptic-lanceolate, gland-dotted leaves, found throughout India upto an altitude of 5,000 ft. Fruit globular wrinkled or warty, varying in colour from dull red to nearly black ; a short pedicel is often present ; pericarp brittle enclosing a single seed covered with a membrane ; taste slightly astringent and aromatic.

The dried fruits is considered anthelmintic, astringent, carminative, alternative and stimulant.

The drug contains (dry basis) : embelin, 2.5-3.1 ; quercitol, 1.0 ; and fatty ingredients, 5.2 % an alkaloid, christembine, a resinoid, tannins and minute quantities of a volatile oil are present.

The dried fruits of *E. tsjeriam cottan* are used in decoction for fevers and for diseases of the chest and skin. They are also used as an ingredient of applications for ringworm and other skin diseases. An infusion of the roots is given for coughs and diarrhea. Aqueous extracts of the fruit show anti-bacterial activity against *staphylococcus aureus* and *Escherichia coli*. Dried fruits are commonly employed as adulterant of black pepper.



Table - 27: Processing and driage percent of *E. tsjeriam cottan*

S. No.	Samples	R1 (gm)	R2 (gm)	R3 (gm)	Av. (gm)
1.	Green weight	1.000	1.000	1.000	1.000
2.	Dried weight	0.500	0.490	0.515	501
3.	No. of days dried	7	7	7	7
4.	Driage percent	50 %			49.9 %

S. No.	Treatments	Fresh wt.(in gms)	Days	Mean dry wt.	Driage %
1.	Sun drying	1000	7	501	49.9

29. *Ocimum tenuiflorum* (Vantulsi)

An erect, herbaceous, much-branched, softly hairy annual, 30-75 cm. high, found throughout India ascending upto 1,800 m. in the Himalyas, Leaves elliptic oblong, acute or obtuse, entire or serrate, on both sides, minutely gland-dotted ; flowers purplish or crimson, in *races*, close whirled ; *nutlets* sub-globose or broadly ellipsoid, slightly compressed, nearly smooth pale brown or reddish, with small black markings.

O. sanctum is commonly cultivated in gardens; it is frequently found as an escape. The plant is held sacred all over India and frequently grown in courtyards and temples. Atleast two types of *O. sanctum* are met with in cultivation ; the green type (*Sri tulsi*) bears purple leaves. The plant is propagated by seeds. It is susceptible to powdery mildew.

The leaves on steam-distillation yield a bright yellow volatile oil processing a pleasant odour characteristics of the plant with an appreciable note of cloves. The yield of oil varies with type, season and the place of origin.



The plant is used as a pot-herb; leaves are used as condiment in salads and other foods. It is also reputed to have medicinal properties. Besides the volatile oil, the plant is reported to contain alkaloids, glycosides, saponins and tannins.

The juice of leaves possesses diaphoretic, antiperiodic, stimulating and expectorant properties ; it is used in catarrh and bronchitis, applied to the skin in ringworm and other cutaneous diseases and dropped into the ear to relieve earache.

Table 28 : Processing and driage percent of *Ocimum tenuiflorum*

S. No.	Samples	Average
1.	Fresh weight of plant	900
2.	Initial moisture content	64.04 %
3.	No. of days dried	6
4.	Moisture content after drying	4.05 %
5.	Driage percentage	82.5 %

30. *Withania somnifera* (Ashwagandha)

An erect, evergreen, tomentose shrub, 30-150 cm high, found throughout the drier parts of India in waste places and on bunds ; also cultivated to a limited extent for the medicinal roots. Roots stout flesh, whitish brown; leaves simple ovate, glabrous; flowers inconspicuous, greenish or lurid-yellow, in axillary, umbellate cymes; berries small, globose, orange-red when mature, enclosed in the persistent calyx ; seeds yellow, reniform.

Ashwagandha is mentioned as an important drug in the ancient Ayurvedic literature. It consists of the roots, which were prescribed for hiccup, female disorders, cough, rheumatism and dropsy, and as a sedative in cases of senile debility.

The dried whole roots undergo cleaning, trimming and grading before dispatch. They are beaten with a club to remove adhering soil and the thin lateral rootlets. The main tap-root may be cut into transverse pieces. The roots are carefully hand-sorted into four grades, based on thickness and uniformity of pieces. The fourth grade consists of thin and wiry roots, rarely exceeding 3 diam. and are partially useless as a drug. *Ashwagandha* is useful in the treatments of inflammatory conditions, ulcers and scabies when applied locally.



Table 29: Processing and driage percent of *Withania somnifera*

S. No.	Samples	Days of drying	Initial weight of (in gms)	Weight on drying	Driage %
1.	As hgand	20	1000	315	68.5
2.	As hgand	15	1000	250	75.0

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