



## Assessing the resource potential of Cheura (*Diploknema butyracea* Roxb.) in Kumaun region of Uttarakhand

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### Abstract

The present study was carried out across 10 different areas spread across Nainital, Champawat and Pithoragarh districts during the year 2015-2016. Total 34 potential areas were surveyed and 10 areas were selected where density of Cheura trees was above 40 trees ha<sup>-1</sup> and the spread of Cheura trees in at least 4ha. The sites were located between 850 and 1450 m altitude. The purpose of the study was to assess resource base and to evaluate the seed oil content of the species. The complete resource assessment and inventory was done for Cheura trees in the all studied areas. 200 permanent plots of 10×10 m<sup>2</sup> (20 at each site) were placed randomly in the study area. The circumference was measured with help of meter tape and height was measured with the help of Ravi Multimeter. The continuous extraction process was used for oil extraction using a soxlet apparatus and hexane which was used as a solvent. Across the sites density of the species ranged between 40 - 95 individuals ha<sup>-1</sup>. The average fruit yield tree<sup>-1</sup> varied between 267.27 and 664.05 kg tree<sup>-1</sup> the seed yield varied 29.86 and 75.15 kg tree<sup>-1</sup> and kernel yield varied 17.11 and 42.11 kg tree<sup>-1</sup>. The average kernel oil content percent ranges between 46.69 ± 2.02 % and 64.24 ± 2.38 %. The areas have a potential to generate income varying between 0.34 and 3.13 lakh ha<sup>-1</sup>.

**Keywords:** cheura, oil content, fruits, kernel, resource base

### 1. Introduction

The Indian Himalayan region (IHR) occupies a special position in the mountain ecosystem of the world as it harbours a rich variety of flora, fauna and cultural diversity (Singh, 2006) [1]. Tree borne oilseeds (TBOs) also known as minor oilseeds are a potential non-conventional source of edible oils. Several forest species yield oil seeds, which are commercially important and available in large quantities. Many of the oilseeds are edible and generally used for food in various forms, such as butter substitute, salad dressings, confectionery etc. (Singh, 2012) [2]. Uttarakhand state forms the major part of the central Himalaya that comprises diverse agroforestry systems (Maikhuri *et al.*, 2000) [3]. Cheura (*Diploknema butyracea* Roxb.) is a large deciduous tree which belongs to the family sapotaceae and occurs in the sub Himalayan tract between 300-1500m above sea level. Flowers of the sapotaceae family members are bisexual (Puri *et al.*, 2017) [4]. The species is a principal source of edible oil in the remote areas of Nepal and Kumaun region of Uttarakhand. It yields edible oil, known in the trade as “Phulwara Butter” which has been classed along with commercial Morwa bassia fats (Singh *et al.* 2010) [5]. It commonly flowers during autumn season and fruit ripens in June-July. The most important part of the tree is the seed whose kernels contain upto 65% oil/fat and is locally known as “Cheura Ghee” or “Phulwara Butter”. Oilseeds and edible oils constitute an important segment of agricultural economy of India. The livelihood security of a multitude of stakeholders (oilseed cultivators, oilseed processors, consumers and other intermediaries) depends on oilseed and edible oil value chain. Land-use systems in the Himalayan region of India comprise forest, agriculture,

horticulture, agroforestry and animal husbandry. These components are interdependent and play a vital role in maintaining the economy of the region. According to FRA-Philippines Country Report (2005) [6], resources assessment is essential for the sustainable management as well as development. One of the most important objectives of resources assessment is to provide forest resources information to support for the development of policies and programs for the management, sustainable development and conservation of forest resources. Considering all the fact Uttarakhand has favourable climatic conditions with adequate wastelands, so the Indian Butter Tree can be adopted under large scale afforestation programmes to gain self sufficiency in natural edible oil (Nautiyal, 2013) [7]. The purpose of the present study was to assess the seed oil content and resources base of the Cheura (*Diploknema butyracea* Roxb) in the Kumaun region of Uttarakhand where it occurs extends widely in the warm valleys and river/stream sides.

### 2. Material and Methods

#### 2.1 Site Description

The study was carried out in two consecutive years i.e., 2014-15 and 2015-16 in 03 districts of Uttarakhand; Nainital, Champawat and Pithoragarh between the elevation 850 and 1450masl. A thorough survey was made through available literature, field visits, personal interviews and PRA exercise in Pithoragarh, Nainital and Champawat and 05 potential areas (P1, P2, P3, P4 and P5) at Pancheshwar valley area in Pithoragarh, 03 (N1, N2 and N3) in Nainital, and 02 (C1 and C2) in Champawat district were selected for the study. During the study period the annual rainfall was between 155 and 206

cm. Rainfall occurs during mid-June to middle September (monsoon season). Temperature remained high between March and July, where it reached close to mean maximum of 40°C. Temperature varied according to climatic condition,

which tends to change drastically. January and February were the coldest months while May and June were the hottest months. The details of the selected areas are as follows:

**Table 1:** Details of selected areas for the study.

S. No.	Districts	Area	Elevation	Coordinates
1	Nainital	N1 Chukuchor	1250	N 29°16'42.81 and E 79°37'46.47
		N2 Bhaursa	1100	N 29°16'22.51 and E 79°37'9.48
		N3 Lamjala	950	N 29°17'31.87 and E 79°36'28.77
2	Pithoragarh	P1 Khitoli	1280	N 29°30'8.30 and E 80°10'11.10
		P2 Gogna	1250	N 29°30'7.80 and E 80°8'52.00
		P3 Jamradi	940	N 29°28'52.82 and E 80°10'54.84
		P4 Bera	1450	N 29°29'51.90 and E 80°10'39.70
		P5 Nisni	950	N 29°28'39.40 and E 80°10'38.50
3	Champawat	C1 Churani	850	N 29°29'8.69 and E 80°5'38.34
		C2 Chamoli	930	N 29°25'39.28 and E 80°8'36.21

## 2.2 Vegetative analysis and Phenology

20 permanent plots of 10×10 m<sup>2</sup> were placed randomly in each 10 potential areas. The circumference was measured with the help of meter tape (Saxena and Singh 1982) [8].

## 2.3 Resource Base

For assessing of resources base of Cheura (*Diploknema butyracea*) in the Uttarakhand the three potential districts; Pithoragarh, Champawat and Nainital with maximum Cheura trees were studied. Total 18 areas in Pithoragarh, 09 in Champawat and 07 in Nainital were surveyed. A thorough survey was made through available literature, field visits, personal interviews and PRA exercise (Islam *et al.* 2013) [9]. Only those areas were selected which had the density above 40 trees/ha of Cheura and spread of Cheura was in excess of 4 ha. After the selection of the potential areas the complete inventory was done for Cheura tree to assess the resources base. At each area 20 individual healthy and disease free trees of large crown were marked for assessing the fruit/seed and oil yield per tree (Barik *et al.*, 1996) [10]. The fruit/seed/kernel yield estimation was made by counting the number of branches, twigs/sub branches, number of branches per twigs and number of fruit per bunch (Eq.1)

$$\text{Fruit or Seed Weight} = \frac{\text{Number of fruits or seeds on tree} \times \text{Average weight of 1 fruit or seed (g)}}{1000 \text{ (g)}} \quad (\text{Eq.1})$$

The mean fruit, seed and oil yield per tree was multiplied by total number of seed bearing trees present in the area for assessing the resource base of fruit/seed and oil (trees having less than 30 cm circumference were not consider for resource base).

## 2.4 Oil extraction

Seeds from 20 marked trees in each area were collected and mixed to make a composite samples, 05 samples were taken from each composite sample for oil yield estimation per site. Kernel was extracted ground to pulp form and subjected to oil yield estimation. The continuous extraction process was used for oil extraction using a Soxhlet apparatus and hexane which was used as a solvent (Akpan *et al.* 2006) [11].

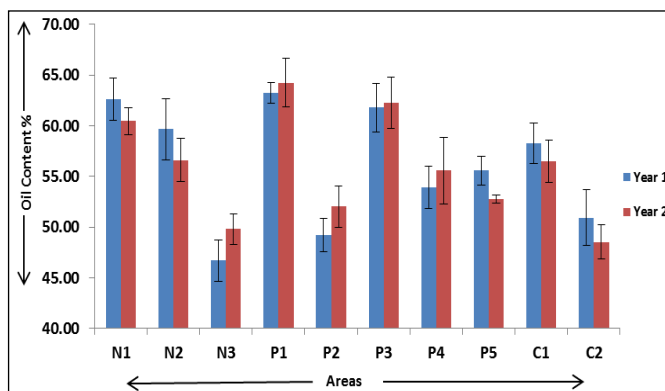
## 3. Results and Discussion

### 3.1 Vegetative analysis and Phenology

The density of Cheura in the selected areas ranged between 40 and 95 individuals/ha. The tree circumference varied between 28.0 ± 1.13 cm and 356.0 ± 1.15 cm. The flowering occurred during the winters and fruits ripened between June and July. Mid June to July was the peak month to harvest/collect the fruits/seeds for oil extraction Fruits were manually de-pulped to obtain seeds which were then air dried in the shade at room temperature. The fruits of Cheura were yellowish – green and elongated-oval shaped and seed colour was light brown.

### 3.2 Oil content

The kernel oil content ranged from 46.69 ± 2.02 % to 63.22 ± 1.05 % in Yr-1 and 49.80 ± 1.52 % to 64.24 ± 2.38 % in Yr-2. The maximum oil yield was 64.24 ± 2.38 % in area P1 (Khitoli) at Pithoragarh district and minimum was 46.69 ± 2.02 % in area N3 (Lamjala) in Nainital district. (Fig.1) ANOVA shows that the oil content was highly significant across the areas and insignificant across the year (P<0.005%).



**Fig 1:** Kernel oil yield from different sites in Yr-1 and Yr-2.

### 3.3 Fruit/Seed yield estimation

In present study the average fruit yield tree<sup>-1</sup> varied between 267.27 and 664.05 kg tree<sup>-1</sup> the seed yield varied 29.86 - 75.15 kg tree<sup>-1</sup> and kernel yield varied between 17.11 and 42.11 kg tree<sup>-1</sup>. (Table 2). The average kernel oil content percent from Cheura ranged between 46.69 ± 2.02 % and 64.24 ± 2.38 %.

**Table 2:** Approximate range of fruit, seed and kernel yield tree<sup>-1</sup> in the studied areas.

Sites	Fruit Yield (Kg tree <sup>-1</sup> )	Seed Yield (Kg tree <sup>-1</sup> )	Kernel Yield (Kg tree <sup>-1</sup> )
N1	259.69 - 625.83	25.39 - 68.16	18.96 - 44.87
N2	270.99 - 662.68	36.58 - 75.26	16.26 - 40.84
N3	256.70 - 592.77	29.62 - 69.35	13.26 - 41.27
P1	267.70 - 662.55	30.44 - 75.34	18.26 - 45.20
P2	267.67 - 682.52	27.89 - 79.34	17.27 - 43.57
P3	268.92 - 702.99	31.64 - 82.18	18.03 - 42.69
P4	268.59 - 692.55	33.64 - 79.36	18.12 - 42.36
P5	275.73 - 661.53	29.56 - 71.55	15.13 - 39.27
C1	271.82 - 669.20	24.22 - 73.69	19.56 - 42.36
C2	264.89 - 687.88	29.65 - 77.25	16.25 - 38.69
Mean	267.27 - 664.05	29.86 - 75.15	17.11 - 42.11

### 3.4 Resource Base

The total numbers of fruiting trees in the studied areas are 15,479 approximately. Fruit yields, seed yield and oil yield and total yield from the area of a season were estimated by multiplying the minimum and maximum values for each parameter/tree to get the range. Total fruit yield across all studied areas was ranged from 4142.73 to 10293.71ton, seed yield was 458.45 to 1162.91ton, kernel yield was 271.19 to 661.80 ton and oil yield was 126.62 to 425.14 ton. The maximum number of trees 3,125 were in the area P1 (Khitoli) at Pithoragarh district and minimum 680 were in N3 (Lamjala) at Nainital district. Similarly the maximum range of fruit yield

836.69 to 2070.79 ton, seed yield 95.14 – 235.48 ton, kernel yield 57.08 – 141.29 ton and oil yield 26.65 – 90.76 ton was in P1 (Khitoli) at Pithoragarh district and the minimum range of fruit yield 174.55 – 403.08 ton, seed yield 20.14 – 47.16 ton, kernel yield 9.02 – 28.06 ton and oil yield 4.21 – 18.03 ton was in N3 (Lamjala) at Nainital district. The maximum income from Cheura oil ranged between Rs. 23.99 and 108.99 lakh in P1 (Khitoli) at Pithoragarh district and minimum between Rs. 3.79 and 21.63 lakh in N3 (Lamjala) at Nainital district. The total gross income from Cheura oil ranged from Rs. 113.96 to 510.17 lakh. (Table. 3)

**Table 3:** Resource base of Cheura trees in the studied area. The values have been derived by multiplying the range of minimum and maximum production/tree at each site (20 trees where sampled at each site).

Sites	Average area (ha)	Density (ind. ha-1) of Cheura Trees	Average number of Trees in the area	Fruit Yields (ton)	Seed Yield (ton)	Kernel Yield (ton)	Oil Yield (ton)	Income (Rs. Lakh) (@ 90 - 120 Rs/Kg)
N1	22.50	85.00	1912.50	496.66 - 1196.90	48.55 - 130.35	36.26 - 85.81	16.93 - 55.12	15.24 - 66.15
N2	20.20	70.00	1414.00	383.18 - 937.03	51.72 - 106.42	22.99 - 57.74	10.73 - 37.09	9.66 - 44.51
N3	17.02	40.00	680.00	174.55 - 403.08	20.14 - 47.16	9.02 - 28.06	4.21 - 18.03	3.79 - 21.63
Total	59.72	195.00	4006.50	1054.40 - 2537.02	120.41 - 283.93	68.27 - 171.61	31.87 - 110.24	28.69 - 132.29
P1	32.90	95.00	3125.50	836.69 - 2070.79	95.14 - 235.48	57.08 - 141.29	26.65 - 90.76	23.99 - 108.92
P2	43.00	50.00	2150.00	575.49 - 1467.42	59.97 - 170.59	37.12 - 93.66	17.33 - 60.17	15.60 - 72.20
P3	18.50	45.00	832.50	223.88 - 585.24	26.34 - 68.42	15.01 - 35.54	7.01 - 22.83	6.31 - 27.40
P4	25.50	60.00	1530.00	410.94 - 1059.60	51.47 - 121.43	27.73 - 64.81	12.95 - 41.63	11.65 - 49.96
P5	19.20	70.00	1344.00	370.58 - 889.09	39.73 - 96.16	20.33 - 52.78	9.49 - 33.90	8.54 - 40.69
Total	139.10	320.00	8982.00	2417.58 - 6072.14	272.65 - 692.07	157.28 - 388.08	73.43 - 249.30	66.09 - 299.16
C1	24.02	65.00	1561.30	424.40 - 1044.82	37.81 - 115.05	30.53 - 66.13	14.26 - 42.48	12.83 - 50.98
C2	18.60	50.00	930.00	246.35 - 639.73	27.58 - 71.85	15.12 - 35.98	7.06 - 23.12	6.35 - 27.74
Total	42.62	115.00	2491.30	670.75 - 1684.55	65.39 - 186.90	45.65 - 102.11	21.31 - 65.60	19.18 - 78.72
Gross Total	241.44	630.00	15479.80	4142.73 - 10293.71	458.45 - 1162.91	271.19 - 661.80	126.62 - 425.14	113.96 - 510.17

### 3.5 Discussion

Production of TBOs on wastelands meets the twin objectives of rehabilitation of a vital natural resource and obtaining an energy substitute. This is a highly appealing combination because it includes a number of ecological and economic benefits. Establishment of agroforestry systems with TBOS on vast areas of barren or scrub land as well as less fertile farm land will change the rural landscape and bring with it many environmental benefits. Cheura ghee has high potential to be used in the manufacture of, cosmetics, soaps and in pharmaceutical and confectionery industry. The fatty acid composition is also important from the point that commercial

ghee in Nepal is often adulterated with Cheura seed oil (Jha, 1981) [12].

According to the R & D outcomes 2014-15 of NOVOD Board [13], the oil content % of Cheura ranged between 51 % and 64%, which is very close to the present results. The oil content of the other species in the R & D outcomes was; Jatropha 35-40%, Jojoba (*Simmondsia chinensis*) 50 – 55%, Karanja (*Pongamia pinnata*) 30 – 35%, Kokum (*Garcinia indica*) 30 – 35%, Neem (*Azadiracta indica*) 30- 50%, Simarouba (*Simarouba glauca*) upto 60% and wild apricot (*Prunus armenica*) 45 – 50%. When these values are compared with present study the Cheura kernel oil content (46.69 ± 2.02 %

and  $64.24 \pm 2.38$  %) was higher than these values and reveals that the Cheura has huge potential in edible oil for the region as well as for the country.

In the earlier studies Tewari *et al.*, (2015) <sup>[14]</sup> reported that average fruit yield of *Diploknema butyracea* (Roxb.) varied between  $140 \pm 1.81$  kg tree<sup>-1</sup> and  $250 \pm 5.24$  kg tree<sup>-1</sup> whereas average seed yield varied between  $28.1 \pm 0.52$  kg tree<sup>-1</sup> and  $45 \pm 0.94$  kg tree<sup>-1</sup> and average kernel yield varied between  $17.8 \pm 0.59$  kg tree<sup>-1</sup> and  $33.7 \pm 0.70$  kg tree<sup>-1</sup>. In present study the average fruit yield tree<sup>-1</sup> varied between 267.27 - 664.05 kg tree<sup>-1</sup> the seed yield varied 29.86 - 75.15 kg tree<sup>-1</sup> and kernel yield varied 17.11 - 42.11 kg tree<sup>-1</sup>. Cheura Ghee/oil production can be viable option for livelihood generation of local farmers as the oil is generally sold between at 90 - 120 Rs./lit. The present study shows that the approximate total fruit yield was 4142.73 to 10293.71ton, seed yield was 458.45 to 1162.91ton, kernel yield was 271.19 to 661.80 ton and oil yield was 126.62 to 425.14 ton. It can generate income of approximately Rs. 113.96 – 510.17 lakh and may be helpful in the economic upliftment of the livelihood generation of the region. Other than the oil the farmer can produce Cheura honey as well as get fodder, fuel wood, timber and other by – products from Cheura plantation. The average income from other by-products is estimated above Rs. 1.0 lakh ha<sup>-1</sup> year<sup>-1</sup> (Tewari *et al.*, 2015) <sup>[15]</sup>. At present, the tree borne oilseeds (TBO's) contribute an insignificant portion of vegetable oil production in the country mainly due to lack of improved varieties, elite planting material and agronomic practices. Promoting TBOs has many benefits to the country and the environment in terms of additional supplies of edible oils and employment to needy population.

#### 4. Conclusion

The results of present study indicate that Cheura seeds have high oil content percentage. It can be an appropriate option for income source for the local community of the region and may play an imperative role in self-sufficiency of edible oils production in near future.

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