

***ALLIUM HOOKERI*, Thw. Enum. A LESSER KNOWN TERRESTRIAL PERENNIAL HERB USED AS FOOD AND ITS ETHNOBOTANICAL RELEVANCE IN MANIPUR**

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ABSTRACT

Manipur, one of the north-eastern states of India, is rich in plant diversity and the natives of Manipur have ethnobotanical and traditional knowledge of plants. The rich traditional knowledge of plants is the outcome of a number of hit and trial selections of plants from the wilderness, for consumption and traditional healing of various ailments. In spite of the risk of selection, the diverse food plants provide the required nutrient supplements; as a result deficiency or malnutrition related diseases were uncommon with the Manipuris. Almost all the world renowned sportspersons of Manipur come from poor families who depend on the traditional and indigenous food plants. Many of the plants act as important nutraceuticals, possessing the medicinal properties. Today, due to over exploitation and under production of indigenous food plants, the lifestyles of the people are changed and they prefer 'junk foods'. Subsequently, the health of the people is deteriorating as the indigenous/traditional food plants are neglected at large. The plant is used as spice/condiment in dry or in fresh form in every household in almost all the traditional dishes. It acts as a good supplementary food, providing food security at the household level and help at the time of food crisis. The cultivation of this wild plant (now cultivated to a limited extent) not only generates income for the growers but also helps in the conservation of the plants and their germplasm. In spite of the immense use, *Allium hookeri* cultivation and its preservation has been decreased due to lack of research-based information of the plant, and due to the concept that wild/traditional plants are poor in nutrition and meant only for the poor. Moreover, agriculturalists and farmers take interest in the cultivation of only the high yielding few cash crops and vegetables. From the result of biochemical analyses, the field survey report and the information from literature, it is known that the plant is fit for consumption and has ethnobotanical relevance. The result of the survey in the urban markets and the rural vendors shows that *Allium hookeri*, Thw. Enum. is of high socio-economical relevance.

Key words: nutrition, farmers, vegetables, rural, rhizome

INTRODUCTION

Manipur, one of the north-east states of India (Fig.1), known for its diverse flora is the home of many indigenous wild food plants. The study site, Manipur, lies at the border area of India and Myanmar.

Mixed populations of Meitei (Major Community), Meitei Brahmins, tribal (twenty-nine legally accepted tribes), Meitei panghals and Nepalese inhabit the state. The ethnic communities (Manipuri) inhabiting the state use wide varieties of wild plants about 400 species, ranging from algae to angiosperms as food [1]. *Allium hookeri*, Thw. Enum. of Liliaceae family, locally known as “maroi napakpi” is a wild herb growing in a wide range of soils. Unlike onion or any other *Allium* species, *A. hookeri* has hardly any bulb; instead a much reduced underground rhizome produces fibrous roots [2]. The leaves of *A. hookeri* are thick evergreen, linear with prominent midribs, basal leaves membranous, and shorter than the tall subtrigonus scape. Edible parts of *A. hookeri* are different from onion, and instead of the fleshy scale leaves born on the axils of the underground reduced stem (bulb) of onion, the thick, flat, green leaves with prominent midrib and the white fibrous roots represent their edible parts. At present, the cultivation of the plant has started at small scale in the fields, kitchen garden and as pot-herbs for a sustainable food security. This plant was once recognized as one of the vegetable items, condiments/spices of daily importance in all the Manipuri households. The taste and aroma of this plant has been preferred over the use of onion in the preparation of recipes by the family members irrespective of the family income, age and sex. Since *A. hookeri* has been associated with the traditional recipes of meiteis and also with the ethnotherapy of certain diseases by local healers since the time immemorial, the plant has been regarded as ethnobotanic relevance to the Manipuris. The objective of the study is to generate detailed information on the mode of consumption and the types of recipe preparation of *Allium hookeri* and study their market potential. To carry out the quantitative and qualitative phytochemical analysis of the edible parts of *A. hookeri* and compare its nutritional values with the common vegetable like onion. In developing countries, lesser known plant species are used as food, many of which are not cultivated but gathered from natural habitats and several of these plants are reported to have medicinal properties [3]. The present study helps to introduce *Allium hookeri* as a supplementary food and as a better substitute of the famous vegetables like onion. The indigenous food constitutes a group of foods that are produced in homes, and villages at prices within the means of the majority of the consumers constituting the developing world. Examination of these foods may, therefore, provide clues as to how food production can be expanded and thereby contribute to improved nutrition in the developing world in the future [4]. Traditional food plants have numerous advantages, especially in terms of household food security. In addition to broadening the food base, they increase the food supply and add variety to the diet [5]. *Allium hookeri* is also available in the Himalayan range including Nepal, China [6].

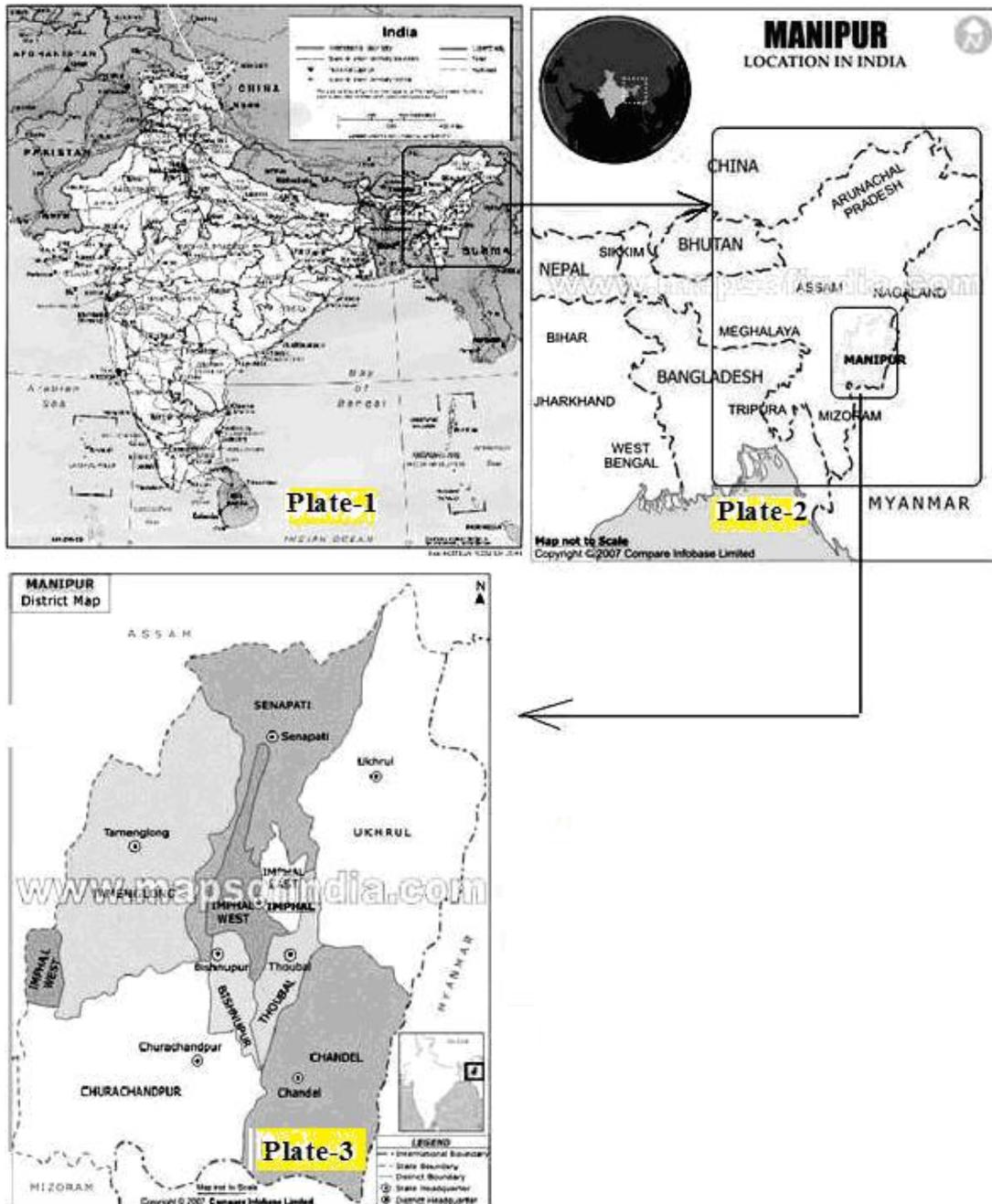


Plate-1: MAP OF INDIA.

Plate-2: MAP OF NORTH-EASTERN STATES.

Plate-3: MAP OF MANIPUR.

Fig-1.-LOCATION MAP OF MANIPUR(Study site)

Though the plants are grown in other places, they are treated as ornamental plants or weeds as their utilization is not known to them, which otherwise are socio-economically important. Plants are either gathered from the wild or collected from the

fields by the farmers and sold to the agents in the main markets of the plain districts of the state, who act as the wholesalers who then sell to the retailers who in turn sold it to the sub-retailers. In the larger markets of the hill districts, collected plants are sold by farmers to retailers, which are then sold at retail prices to sub-retailers, who in turn sell it to customers and wholesalers were absent. In smaller markets farmers sold them at sub-retail prices and wholesalers and retailers are absent. *A. hookeri* are preserved at households by sundry method and parcelled to students and relatives who stay outside the state. Thus, indicating the possibility of marketing even to the areas where the natural growth does not occur. For the authenticity and fitness as a supplementary food, the detailed analyses of the nutritional parameters of the edible parts (leaves and roots) were carried out in terms of biochemical estimates. The analysis includes quantitative estimation of starch, total soluble sugar, reducing and non reducing sugars, total phenol, phytosterols, total protein, total amino acids, varying quantities of different types of amino acids, total fat, ascorbic acid, total nitrogen, soluble and insoluble nitrogen, moisture and dry matter percentage. Since *Allium hookeri* plays a major role as a food substitute, providing food security and supports many families financially, the analysis of its market potential was considered essential and the survey of local markets and villages was conducted.

MATERIALS AND METHODS

Location of study site:

The study site comprises the nine districts of Manipur, one of the North-Eastern States of India surrounded by the neighboring states like Nagaland, Assam and Mizoram and is situated at the border area with Myanmar as its immediate neighbor. The state is located at 93.03^oE & 94.78^oE longitude, 23.83^oN & 25.68^oN latitude and altitude of 781 to 2020 m from the sea level. Out of the total of nine districts, four are in valleys such as Imphal West, Imphal East, Thoubal, Bishenpur, which is surrounded by the remaining five hilly districts namely, Senapati, Ukhul, Tamenglong, Chandel, and Churachandpur. *A. hookeri* is found more in the valley district, which is at 790 m. altitude, between 93.42^oE to 94.47^oE longitude and between 23.83^oN to 25.41^oN latitude and comprises of an area of 2238 sq. km, which is 10% of the total area and the remaining 90% comprises of hills [7].

Ethnicity of the study site: Populations in hills and valley comprise 36 % and 64 %, respectively of the total population of state of Manipur. Meiteis, the valley dwellers, are the major community with a population of 13, 61,521 out of the total population of 23, 88,634 of the state as per 2001 Census [8, 9, 10]. The other minorities are namely: Muslims (riverbed dwellers), Nepalis (hill dwellers) and 29 legally recognized tribes with 16 unrecognized minor tribes (hill dwellers). Different communities have different dialects but a common communication language is *meiteilon*, the mother tongue of the major community, meiteis.

Survey and collection of information on the utility and ethnomedicinal importance of the plant:

Information on the use and utility of *Allium hookeri*, as food and medicine was generated through household survey and personal interaction with the local people in rural and urban areas of Manipur during January, 2009-11. The details of the indigenous recipes of *Allium hookeri* and the methods of preparation were then recorded and tabulated (Table 1). Female members of the families especially the housewives, mothers and female elders were the most important respondents during the survey as they are the ones engaged in daily cooking and kitchen works who could tell about the recipes. The recipe components of daily consumption and the frequencies of consumption were recorded (Table 2). The leaves' juice with salt is also used as a source of medicine to cure ulcer and stomach ailments by the local healers. The leaf decoction (**Decoction** is a method of extraction, by boiling, or dissolved chemicals, or herbal or plant material, which may include stems, roots, bark and rhizomes.) paste is applied on forehead in reducing excessive body temperature and blood pressure [11].

Analysis of edible parts of *A. hookeri*:

Plants were collected from the natural habitats and markets of the study sites for the phytochemical analysis. Unlike onion, *A. hookeri* have no bulb and the edible parts were represented by the thick, green, flat, linear leaves and the fibrous roots both born on rhizome. The rhizome is negligibly small with a length of 1-2 cm and a thickness of 3-4 mm and is without any peculiar taste; hence, it is not considered as an edible part, though sometimes it is taken along with the roots. The edible parts (leaves and roots) were analyzed using different analysis methods and the quantities present were recorded (Table 3). Carbohydrates were determined using: i) Anthrone method [12] for the estimation of total soluble sugars (TSS), ii) Nelson's method for estimation of reducing sugars [13] (RS), iii) methods of Malhotra and Sarkar for non-reducing sugars according [14] and iv) the Anthrone method derived from i) for the estimation of total starch. (TS). Total fat (TF) was determined using the method of Leslie and Fisher [15], the Ninhydrin method [16] was used for estimation of total amino acids (TAA), qualitative analysis of the individual amino acids was with the Thin Layer Chromatography method [17], and the elution technique for quantitative estimation of individual amino acids. Total nitrogen (TN) was determined with the micro-Kjeldahl method and soluble and insoluble nitrogen (SNF, INTF) using the method of Lang [18]. Ascorbic acid content was determined with the indophenol reduction method [19]. Total phenol was determined with the Folin-Ciocalteu's method [20] and total phytosterol (TPS) with the Libermann-Burchard reaction method [21]. Moisture content was determined according to the AOAC methods [22].

Comparison of some of the important nutritional components of *A. hookeri* with *A. cepa*: USDA nutrient database of onion [23] is compared with that of the *A. hookeri* (Table 4).

Study of the market potential of *A. hookeri*:

The market potential of *Allium hookeri* was determined after a survey of wholesalers, and retailers (vendors) in different urban and rural markets of the state, during the luxuriant growth period (April to June), during 2009-2011 (tables 5, 6 & 7). The results of the survey were analysed for determining the socio-economic relevance of the plants.

RESULTS

Table 1 shows the type of recipes of *Allium hookeri* and their modes of preparations as cited by the respondent households. The frequencies of utilization of the recipes are expressed based on the number of respondents that cited a particular recipe, out of the 450 households that were interviewed in the 9 districts of Manipur. Only the recipes cited by more than 50% of the respondents are tabulated. From the table, the parts utilized were known to be the green aerial leaves and the associated underground white rhizomes (Fig.2).



Fig.2: Photos of one of the vegetable markets selling *Allium hookeri* and showing the edible parts of the plant parts

Figure 2: Photos of a vegetable market selling *Allium hookeri* in Manipur and showing their edible parts.

Table 2 shows the frequencies of daily consumption of the recipes among the respondent households which were grouped into three broad categories, namely, *rarely consumed* (consumed less than 2 times a week) and *often consumed* (consumed 2 to 4 times a week), *very often consumed* (consumed more than 4 times a week). The frequencies of consumption of the different recipes were compared by applying a weight of 1, 2 and 3 to the frequencies for “rarely”, “often” and “very often”, respectively, to obtain the composite score, which was used to compute a mean score. Table 3 shows the quantitative nutritional contents of leaves and roots of *A. hookeri*, namely, total sugar, reducing sugar, non-reducing sugar, starch, total nitrogen, soluble and insoluble nitrogen, total crude protein, total amino acids, different amino acids composition, total fat, total phenol, total phytosterols, vitamin C, fibre percentage and moisture percentage obtained by the different biochemical analysis methods. The differences in the quantities between the leaves and the rhizomes are significant at $p \geq 0.05$. Amino acids, namely, aspartic acid, threonine, valine, phenylalanine and tryptophan are present only in the leaves; whereas alanine, histidine and nor-leucine only are in rhizomes while methionine, glycine and lysine occur in both (Figures 3 & 4).

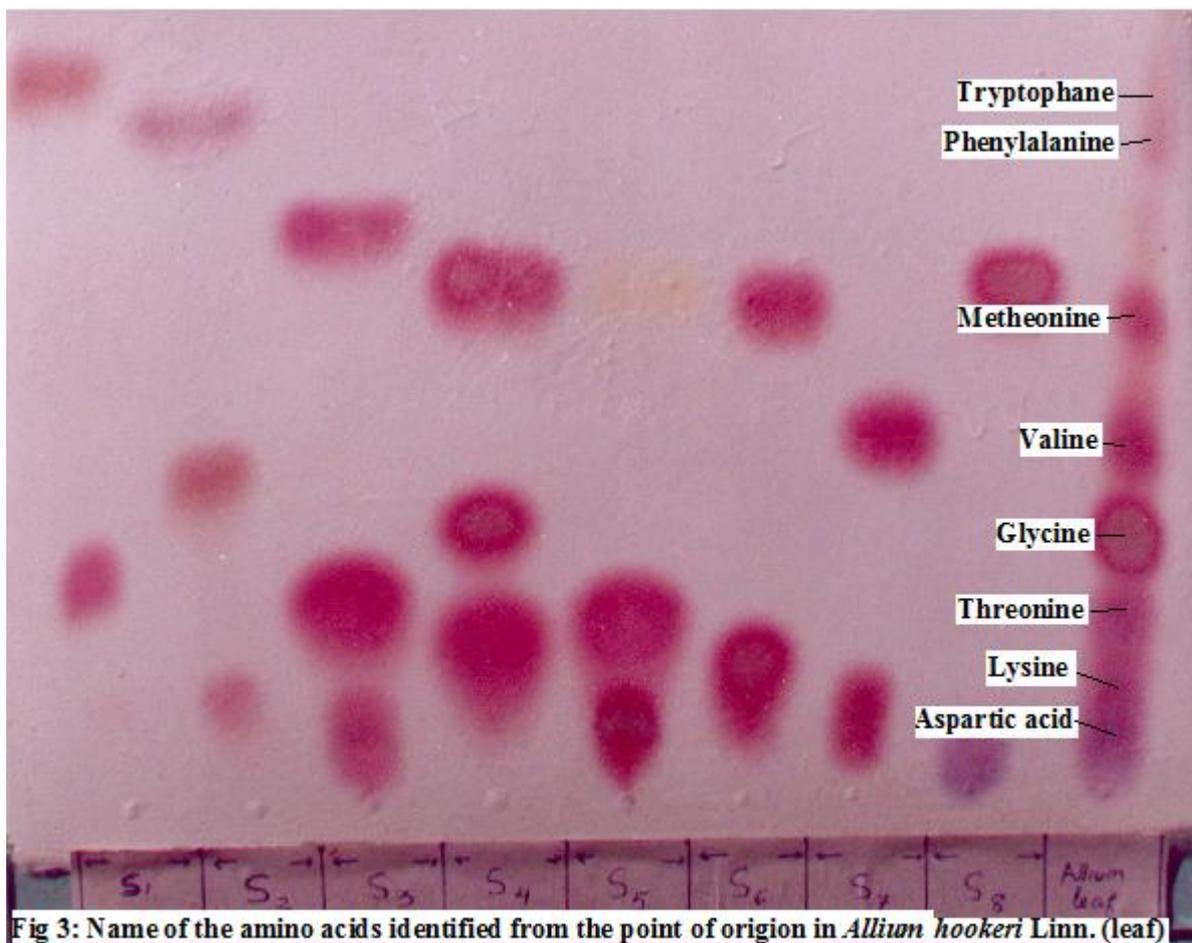


Fig 3: Name of the amino acids identified from the point of origin in *Allium hookeri* Linn. (leaf)

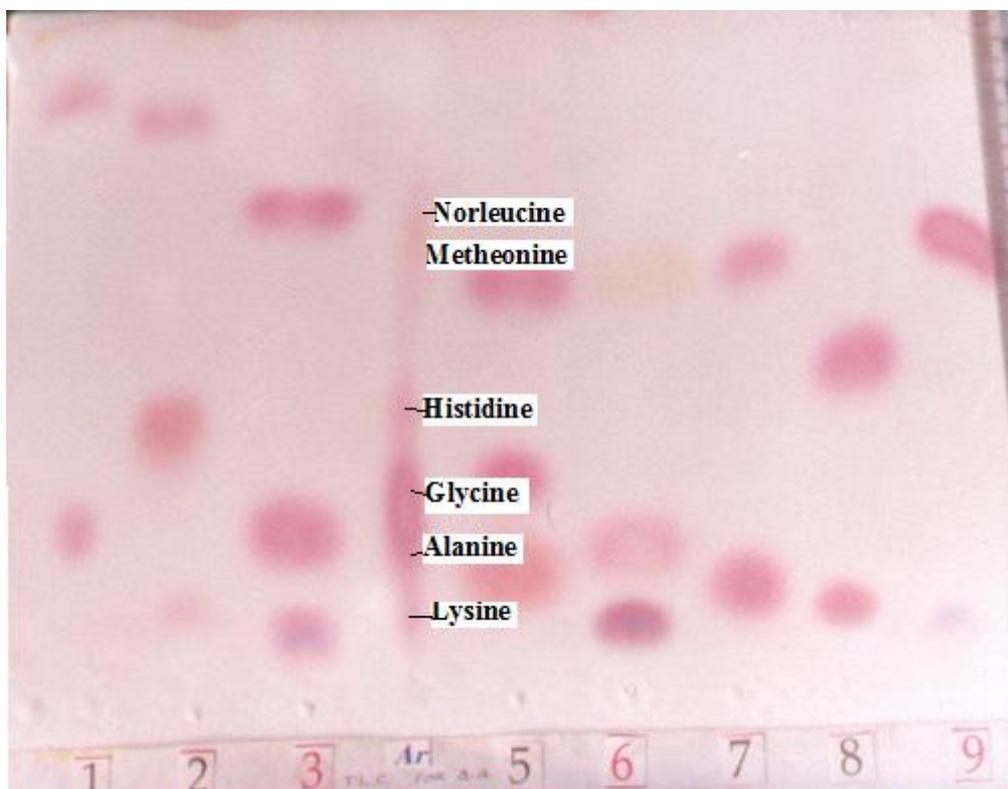


Fig 4: Name of the amino acids identified from the point of origin in *A. hookeri*(root).

Table 4 shows the amount of total protein, sugar, fibres, ascorbic acids and total phytosterols in *A. Hookeri*. These amounts are higher than those in of *A. cepa*. The amount of fat is lower in *A. hookeri* than that in *A. cepa*. An amount of 0.1g 100g⁻¹ dry wt. (0.1% of the dry weight) of total phytosterols is present in *A. cepa* [24].

Tables 5 and 6 show market scenarios of *Allium hookeri* in the plain and hill districts of Manipur. The tables also show the wholesale and retail prices of the plant, quantities sold and the total sale prices per day during its peak period (April-June). Plants gathered/collected from the wild/fields are sold to agents (wholesalers) in the main markets, which are then sold to the retailers at wholesale rate, which are in turn sold at retail prices. The prices shown were the mean of 20 separate days of observations of the markets and vendors during the normal and luxuriant growth periods. The tables as a whole show the generation of income from this plant in the households.

Table 7 shows the daily Profit of wholesalers, retailers and sub-retailers (vendors) in the plain and Hill districts of Manipur from *Allium hookeri*.

DISCUSSION

A list of seven recipes of *Allium hookeri*, the ingredients required, the methods of preparation and the frequencies of consumption by the Manipuris was prepared based on a survey carried out in the 450 households, covering the nine districts of Manipur (table1). Generally the recipes are prepared by frying, steaming, baking and boiling which are all popular with slight differences in frequencies of consumption. Over 84.44% households prepared by steaming/baking (maroi napakpi paknum), 68.89% by deep-frying (maroi napakpi bora), other recipes were consumed as maroi napakpi nganum (64.44%), maroi napakpi kangsoy (62.22%), maroi napakpi yerum tal (55.55%) and over 48% are consumed by deep frying with boiling (Maroi napakpi pakoura). A maximum consumption of 98.89% is in the form of spices and condiments in almost all the households. The frequencies of consumption of the recipes show the importance of the plant for household food security (Table 2). The recipes tabulated are popular in grand feasts, traditional ceremonial feasts, parties and are also popularly sold in hotels and restaurants. Thus, this indigenous/traditional food plants not only provide the food security and dietary diversity but also help to generate income in the households.

Allium hookeri contains higher amounts of total protein, sugar, fibre ascorbic acid, phytosterols and total phenols with the lower amount of total fat than *A. cepa*. The presence of higher amount of protein, ascorbic acid and lower amount of fat is a character of healthy food. Moreover, presence of higher concentration of total phytosterols (0.5g/100g fresh weight) and containing a good amount of total phenols (2g.100g⁻¹ dry wt.) (Table 4) is another character of healthy food. Apart from its nutritional contents *A. hookeri* have the better taste and aroma, so can be treated as a better substitute of onion and a worthy supplementary vegetable, spice and/or condiment. In spite of the popularity and high demand, the use of this plant is slowly decreasing due to overexploitation and under cultivation. Phenol and phytosterol which are of very high price in the global markets for their medicinal properties were rich in *Allium hookeri*. The therapeutic benefits of fruits, vegetables, tea and wine are mostly attributed to the presence of phenolic compounds [25]. Percentage intestinal cholesterol absorption decreased with increasing phytosterol intake, resulting in a decrease in dietary cholesterol absorption [26]. Phytosterols can significantly lower serum LDL cholesterol concentrations at about 10% when consumed at the recommended dose of 2 g/d [27]. Phytosterols are used as an efficient cholesterol lowering agent in various food products [28]. Phytosterols are safe when added to the diet, and measured absorption and plasma levels are small. Increasing the aggregate amount of phytosterols consumed in a variety of foods may be an important way of reducing population cholesterol levels and preventing coronary heart disease [29]. According to Wu *et al.*[30] plant flavonoids are polyphenolic compounds and at nontoxic concentration, considered for increasing efficacy in drug therapies. A higher flavonoid (polyphenolics) intake correlates with a lower incidence of coronary heart disease (CHD) [31]. Phenolic antioxidant inhibits the radicals and significantly decreases the adverse effects on normal physiological functions in humans. The phenolic plant extract can be used in the production of food supplements and cosmetic products [32]. Several studies proved that the total phenolics content was highly

positively correlated with antioxidant activity [33]. The efficacy of phytosterols appears to function independently of dietary fat; thus, there has been a movement to incorporate phytosterols into low-fat foods in order to promote a low-fat, low cholesterol diet profile to further improve health lipid profiles [34]. Ethyl acetate extracts of *Allium hookeri* present the best antimicrobial activity [35]. *A. hookeri*, having high phytosterol, phenols, ascorbic acid and fibre and low fat could be treated as a healthy food. From the information of traditional healers and literature, this plant, while consuming as vegetable also reduces blood pressure, stomach ulcer and excessive body temperature. Therefore, *Allium hookeri* could be used as a supplementary food, which simultaneously protects the body from certain diseases. The result of analysis shows upto $6625 \pm 610 \text{ kg} \cdot \text{day}^{-1}$ of *Allium hookeri* is sold by the plant gatherers at an average price of Rs. $80 \pm 5 / \text{kg}^{-1}$ amounting to a total of Rs. 533050 ± 81925 to the wholesalers, which was in turn sold at an average wholesale price of Rs. $88 \pm 5 / \text{kg}^{-1}$ to retailers amounting to a total of Rs. 586050 ± 86805 /day⁻¹. The retailers in turn sold at an average price of Rs. $110.15 \pm 5 / \text{kg}^{-1}$ to the sub-retailers and consumers in the valley markets amounting to a total of Rs. $729150 \pm 110588 / \text{day}^{-1}$. A total amount of $722 \pm 157 \text{ kg} \cdot \text{day}^{-1}$ of *A. hookeri* are bought by sub-retailers from retail markets as well as from the kitchen garden growers at the rate of Rs. $109.62 \pm 5 \cdot \text{kg}^{-1}$ with a total cost price of Rs. $79775 \pm 20760 \cdot \text{day}^{-1}$ which were sold at the sub-retail price of Rs. $125.03 \pm 5 \cdot \text{kg}^{-1}$ amounting to a total sub-retail price of Rs. $91001 \pm 23212 \cdot \text{day}^{-1}$ by sub-retailers in the markets of plain districts of Manipur. Thus, the farmers (plant gatherers/suppliers) earn a net daily profit of Rs. 533050 ± 81925 on *Allium hookeri* from the markets of the plain districts of Manipur (this does not include the small income from selling *A. hookeri* of their kitchen garden to smaller vendors at sub-retail prices). The net daily profits of the wholesalers, retailers and sub-retailers are Rs. 53000 ± 4880 , 143100 ± 13120 and 11226 ± 2452 , respectively, from the valley markets.

In the markets of the hilly districts, farmers/plant gatherers either collecting from wild or from their kitchen garden, and supplies to retailers which are in turn sold to sub-retailers. Sub-retailers bought *A. hookeri* from both the retailers and farmers at different prices, and there were no wholesalers. An amount of $600 \pm 100 \text{ kg}$ of *Allium hookeri* bought at Rs. $88 \pm 5 \text{ Kg}^{-1}$ from the farmers by retailers, are sold at Rs. $112 \pm 5 \cdot \text{kg}^{-1}$ and an average amount of $373 \pm 28 \text{ kg}$ of *Allium hookeri* bought at Rs. $112 \pm 5 \text{ Kg}^{-1}$ both from the retailers and farmers by sub-retailers, are sold at Rs. $130 \pm 5 \cdot \text{kg}^{-1}$ in the markets of the hill districts. The total sale price of the retailers and sub-retailers day⁻¹ are Rs. 67700 ± 14200 and Rs. 48630 ± 5505 , respectively. Therefore, net daily Profits of the retailers and the sub-retailers of *Allium hookeri* from the Markets of the Hill districts of Manipur are Rs. 14400 ± 2400 and Rs. 6714 ± 499 , respectively. The farmers (plant gatherers/suppliers) earn a net daily profit of Rs. 83981 ± 15517 from the markets of the Hill districts of Manipur. Therefore, the net daily profit obtained from *Allium hookeri* in the state is approximately Rs. 761490 ± 105276 .

CONCLUSION

The present study documents the Meiteis recipes of *Allium hookeri*, popular among the Manipuris. The nutritional values and medicinal properties of *A. hookeri* determined, through analysis and from the literature to study the fitness of the plant as a supplementary food. In the course of the survey, it was found that the plant is used in seven different forms, frequently in more than 50% of the households that were surveyed. Thus, the level of utilization of the plant is high and has the potential for agricultural and commercial exploitation. From the analysis, it was determined that *A. hookeri* is a good source of various nutrients and is a better source of sugars, phenol, phytosterols, Vitamin C, fibre and protein than *A. cepa*, while at the same time having lower amount of fat than onion suggests it is a better substitute (table 4). In spite of the food security and financial support provided by *Allium hookeri* at the household levels, the rate of gathering, domestication and consumption is declining in the state. The factors responsible for the decline may be highlighted as the following:-

- Farmers are interested in the cultivation of cash crops instead of the indigenous food plants for earning income; as such the plant has not been given the chance to prove its worth.
- Decline in gathering of the plant and its domestication are due to the limited knowledge of the nutritional compositions and medicinal properties to the farmers, and largely due to emphasis given, on commercial, high yielding plants even by the agriculturalists.
- With the increasing population and expansion of the settlement area, portions of the forests and swamps are encroached, and habitats are used for the cultivation of the already known more aggressively promoted cash crops.
- Due to lack of conservation policy and due to the wrong belief, that local and indigenous plants are less nutritious and only fit for consumption by the poor communities. Moreover, with the changing lifestyle, people prefer “junk foods” which take lesser time for preparation, and are believed to possess better nutrition.

Realizing the requirement of researched knowledge about the nutritional and health values of indigenous food plants, in changing the attitude of agricultural workers and the rural communities, for saving the indigenous food plants from a possible loss, the present study was conducted. Research analyses proved that these food plants are worthy of consumption and should therefore be categorized as healthy food. During the survey, it was also found that many of the households and also the state were financially supported by the plant; hence, the plant has socio-economic relevance.

Table 1: Some of the food recipes of *Allium hookeri* recorded and documented

Name of the Recipes/ utilization	Plant parts used	Frequency N=450	Ingredients	Mode of preparation.
Spices and condiments	Leaves and roots	445	Fresh or dry leaves or roots are used as indigenous spice daily for preparation of most of the recipe. While only fresh leaves are used as condiments. Chopped <i>Allium hookeri</i> leaves with sliced potato, onion, grounded <i>Zingiber officinale</i> Rose., powdered red chilli or chopped green chilli, spices, pulse powder, oil, salt and water.	Chopped leaves or roots are fried in oil and used as spices for almost all the curries and imparts a characteristic flavour. Chopped leaves are used as condiments and eaten raw with fried pulses, beans, potato or with any fried vegetables.
Maroi napakpi Bora	Leaves	310	<i>Allium hookeri</i> leaves, <i>Zingiber officinale</i> Rose. and garlic, powdered red chilli or green chilli, spices, gram/pea flour, oil, salt and water.	Gram/pea flour, spices, chopped or powdered chilli, salt and grounded gingers are thoroughly mixed together with water to form a good paste. Then only the <i>A. hookeri</i> leaves are dipped in the paste and fried in the oil, or a mixture of chopped <i>Allium</i> leaves, slices of onions and potatoes are mixed with the above paste and fried in the oil for making bora.
Maroi napakpi Bora	Leaves	220	<i>Allium hookeri</i> leaves, <i>Zingiber officinale</i> Rose. and garlic, powdered red chilli or green chilli, spices, gram/pea flour, oil, salt and water.	Gram/pea flour, spices, chopped or powdered chilli, salt and grounded gingers and garlic are thoroughly mixed together with water to form a good paste. Then with a handsome amount of chopped <i>Allium hookeri</i> leaves are then pasted thoroughly with the above paste and fried in the oil as in the making bora. Vegetable or dal soups are prepared then it is finally cooked with the above fried bora for preparing pakoura.
Maroi napakpi paknam	Leaves	380	<i>Allium hookeri</i> leave, green chilli, pulse powder, salt roasted fermented fish, leaves of <i>Curcuma domestica</i> and water.	A thick watery paste of pulse powder, salt, roasted fermented fish, Chopped <i>Allium hookeri</i> leaves and chopped green chilli are wrapped by green leaves of <i>Curcuma domestica</i> and are steam cooked and then baked and the preparation looks like a cake with its peculiar taste.
Maroi napakpi Nganum	Leaves	290	<i>Allium hookeri</i> leaves, green chilli, <i>Curcuma domestica</i> leaves and dry/fresh fish.	Sundry / heat dried fishes known as “ngafak” (in Manipuri nga=fish, afakpa=pierced open) or small size fresh fishes are mixed with the chopped leaves of <i>Allium hookeri</i> , green chilli and grounded ginger and wrapped around preferably by green or dry leaves of <i>Curcuma domestica</i> and steam cooked by placing it above the rice during backing which is after boiling during cooking of the rice.
Maroi napakpi Kangsoy	Leaves	280	<i>Allium hookeri</i> leaves, red/green chilli, <i>Zingiber officinales</i> , dry fish, oil and potato.	Dry fish washed in water are fried in a small amount of oil followed with the frying of a small amount of chopped onion, garlic and chopped <i>Allium hookeri</i> leaves, sliced potato may also be added during frying, and water is added in reasonable amount. Red/green chilli, grounded <i>Zingiber officinales</i> and salt are then added to give the delicious recipe.
Maroi napakpi yerum tal	Leaves	250	<i>Allium hookeri</i> leaves, red/green chilli, <i>Allium cepa</i> , and <i>Allium sativum</i> and eggs.	Chopped <i>Allium hookeri</i> leaves, red/green chilli, <i>A. cepa</i> and <i>Allium sativum</i> are mixed with eggs and fried in oil adding desired amount of salt. The omelette so prepared has characteristic test.

Table 2: Frequency of consumption of the various types of recipes of *Allium hookeri*

Name of the Recipes	Frequency	Rarely (x1)	Often (x2)	Very often (x3)	Composite score	Mean score
Spices and condiments	445	5	35	405	1290	2.89
Maroi napakpi Bora	310	20	130	160	760	2.45
Maroi napakpi pakoura	220	62	80	78	456	2.07
Maroi napakpi paknam	380	90	110	180	850	2.24
Maroi napakpi Nganum	290	210	70	10	380	1.31
Maroi napakpi Kangsoy	280	90	170	20	490	1.75
Maroi napakpi yerum tal	250	80	120	50	470	1.88

Table 3: Nutrients in g per 100g dry weight of leaves and roots of *Allium hookeri*

Mean \pm standard deviation in g.100g ⁻¹ dry wt.		
Parts used	Leaves	Roots
Total sugar	1.10 \pm 0.01	4.31* \pm 0.04
Reducing Sugar	0.18* \pm 0.01	0.004 \pm 0.02
Non-reducing Sugar	0.85 \pm 0.03	4.30* \pm 0.01
Starch	0.10* \pm 0.02	0.09 \pm 0.04
Total Fat	0.008 \pm 0.002	0.005* \pm 0.003
Total nitrogen	0.20* \pm 0.02	0.05 \pm 0.01
Soluble Nitrogen	0.09* \pm 0.003	0.005 \pm 0.002
Insoluble Nitrogen	0.068* \pm 0.003	0.014 \pm 0.003
Total crude Protein (from total nitrogen)	1.25* \pm 0.04	0.31 \pm 0.02
Total amino acid contents	0.13* \pm 0.02	0.16 \pm 0.02
Total Phenol	2.00* \pm 0.04	0.10 \pm 0.030
Total Phytosterol	0.50* \pm 0.01	0.13 \pm 0.02
Vitamin C	21 mg* \pm 0.004	1 mg \pm 0.006
Moisture %	88%	92%
Dry matter %	18%	8%
Types of Amino acids present	Asp,Lys,Thr,Gly,Val,Met,Phe,Trp,	Lys,Gly,Met,Nor leu,Ala and His

*Differences significant at $P \geq 0.05$.

Table 4: Comparison of the nutritional contents of *A. hookeri* with *A. cepa* amounts in g•100g⁻¹ fresh wt.

Name of The Plant	Protein	Total Sugar	Total Fat	Phytosterol	Fibre	Moisture	Ascorbic acid (mg/100g)
<i>Allium hookeri</i>	1.25	4.31 (root)	0.005 (root)	0.5g (0.5% of the fresh weight)	18g	88g	21 mg (fresh leaves)
<i>A. cepa</i>	1.1	4.24	0.1	0.1g (0.1% of the dry weight)	1.7g	89.11g	7.4 mg

Table 5: Daily Market scenario of *Allium hookeri* of the wholesale, retail and sub-retail markets of the Plain districts of Manipur in (2009-10).

Name of the market	Category of the Markets	Quantity Sold day ⁻¹	Cost price in Rs.Kg ⁻¹	Sale price in Rs.Kg ⁻¹	Total cost price in Rs.	Total sale Price in Rs.	Total income (profit) in Rs. day ⁻¹
Khwai keithel/ Khwairambad Bazaar	W	6625±610	80±5	88±5	533050± 81925	586050 ±86805	53000 ± 4880
	R	1000±100	88±5	102±5	88500± 13800	102500± 15200	14000± 1400
Bisnupur Bazaar	R	500±50	88±5	115±5	44250± 6900	57750± 8250	13500± 1350
	SR	50±10	115±5	129±5	5800± 1400	6500± 1540	700± 140
Kakching Bazaar	R	600±50	88±5	115±5	53050± 7400	69250± 8750	16200± 1350
	SR	40±8	115±5	129±5	4640± 1120	5200± 1232	560± 112
Thoubal Bazaar	R	600±50	88±5	112±5	53050± 7400	67450± 8600	14400± 1200
	SR	35±7	112±5	126±5	3955± 959	4445± 1057	490± 98
Nambol Bazaar	R	600±50	88±5	112±5	53050± 7400	67450± 8600	14400± 1200
	SR	30±6	105±5	128±5	3180± 780	3870± 918	690± 138
Khurai Bazaar	R	650±50	88±5	110±5	57450± 7650	71750± 8750	14300± 1100
	SR	32±6	110±5	126±5	3550± 820	4062± 916	512± 96
Singjamei Keithel	R	650±50	88±5	108±5	57450± 7650	70450± 8650	13000± 1000
	SR	25±5	108±5	120±5	2725± 665	3025± 725	300± 60
Lilong Bazaar	R	350±40	88±5	110±5	31000± 5270	38700± 6150	7700± 880
	SR	27±6	110±5	122±5	3000± 795	3324± 867	324± 72
Nongmeibung keithel	R	650±50	88±5	108±5	57450± 7650	70450± 8650	13000± 1000
	SR	30±6	108±5	128±5	3270± 798	3870± 918	600± 120
Kongba Bazaar	R	350±40	88±5	110±5	31000± 5270	38700± 6150	7700± 880
	SR	34±7	110±5	120±5	3775± 940	4115± 1010	340± 70
Pisum Keithel	R	225±30	88±5	108±5	19950± 3765	24450± 4365	4500± 600
	SR	27±5	108±5	118±5	2941± 675	3211± 725	270± 50
Jiri Bazaar	R	200±20	88±5	110±5	17700± 2760	22100± 3200	4400± 440
	SR	23±5	110±5	128±5	2555± 665	2969± 755	414± 90
Sekmai Bazaar	R	250±30	88±5	112±5	22150± 3890	28150± 4610	6000± 720
	SR	23±5	112±5	128±5	2601± 675	2969± 755	368± 80

Sugnu Bazaar	SR	40±10	112±5	128±5	4530± 1320	5170± 1480	640± 160
Moirang Bazaar	SR	40±10	108±5	124±5	4130± 1220	5010± 1440	880± 220
Keisamthong Keithel	SR	30±6	108±5	128±5	3270± 798	3870± 918	600± 120
Kwakeithel Bazaar	SR	40±10	102±5	116±5	4130± 1220	4690± 1360	560± 140
Koirenggei Keithel	SR	24±5	112±5	122±5	2713± 680	2953± 730	240± 50
Pangei Bazaar	SR	23±5	110±5	128±5	2555± 665	2969± 755	414± 90
Lamsang Keithel	SR	25±5	112±5	126±5	2825± 685	3175± 755	350± 70
Singda Bazaar	SR	35±7	110±5	126±5	3885± 945	4445± 1057	560± 112
Keisampat Keithel	SR	20±5	102±5	118±5	2065± 610	2385± 690	320± 80
Tera bazaar	SR	20±5	110±5	122±5	2225± 650	2465± 710	240± 60
Lamlai Bazaar	SR	23±5	110±5	128±5	2555± 665	2969± 755	414± 90
Saitu gamphrajol Keithel	SR	12±3	110±5	128±5	1335± 390	1551± 444	216± 54
Arapti Potfam	SR	3±1	110±5	126±5	335± 125	383± 141	48± 16
Oinam Keithel	SR	4±1	110±5	126±5	445± 130	509± 146	64± 16
Yumnam leikai Potfam	SR	3±1	110±5	126±5	335± 125	383± 141	48± 16
Leimakhong Bazaar	SR	2±1	110±5	126±5	225± 120	257± 136	32± 16
Serou Keithel	SR	2±1	110±5	126±5	225± 120	257± 136	32± 16

Total Income earned by the farmers (plant gatherers/suppliers) from the markets of the plain districts of Manipur on *Allium hookeri* day⁻¹ = (total cost price of wholesalers) = Rs. 533050± 81925

Note: W= wholesalers, R=Retailers, SR=Sub retailers. Interest (profit) per day = Sales Price (S.P.) day⁻¹ - Cost Price C.P.) day⁻¹

N.B. 1\$ (USD) = Rs. 45/- in the year 2009-2011.

Table 6: Daily Market scenario of *Allium hookeri* of retail and sub-retail markets of the Hill districts of Manipur in (2009-2010)

Name of the market	Category of the Markets	Quantity Sold day ⁻¹	Cost price in Rs.Kg ⁻¹	Sale price in Rs.Kg ⁻¹	Total cost price in Rs.	Total sale Price in Rs.	Total Income (profit) in Rs. day ⁻¹
Churachandpur Bazaar	R	300±50	88±5	112±5	26650±5900	33850±7100	7200±1200
	SR	40±2	112±5	130±5	4490±424	5210±460	720±36
Wino bazaar	R	300±50	88±5	112±5	26650±5900	33850±7100	7200±1200
	SR	60±5	112±5	130±5	6745±865	7825±950	1080±85
Senapati Bazaar	SR'(VENDOR)	50±5	112±5	130±5	5625±810	6525±900	900±90
Tamenglong Bazaar	SR'(VENDOR)	20±2	112±5	130±5	2250±324	2610±360	360±36
Maram Bazaar	SR'(VENDOR)	15±2	112±5	130±5	1690±299	1960±335	270±36
Mao Bazaar	SR'(VENDOR)	20±2	112±5	130±5	2250±324	2610±360	360±36
Sapermina Keithel	SR'(VENDOR)	40±2	112±5	130±5	4490±424	5210±460	720±36
None Bazaar	SR'(VENDOR)	45±2	112±5	130±5	5050±449	5860±485	810±36
Yaingungpokpi Keithel	SR'(VENDOR)	30±2	112±5	130±5	3370±374	3910±410	540±36
Chandel Bazaar	SR'(VENDOR)	45±2	112±5	130±5	5050±449	5860±485	810±36
Kangpokpi Keithrl	SR'(VENDOR)	8±2	112±5	130±5	906±264	1050±300	144±36

- Wholesalers in markets of hill districts and two of the markets have retailers and sub-retailers while the remaining was of only small vendors (SR'). Plant collectors themselves sold the plant at retail price which in turn were sold at sub-retail prices, but for the markets having only SR', collectors sold to vendors at sub-retail prices.

Total Income earned by the farmers (plant gatherers/suppliers) from the markets of the Hill districts of Manipur on *Allium hookeri* day⁻¹ = (sum of the cost price of the retailers + sum of the cost price of the sub-retail or vendors.) Rs. 83981 ± 15517

Note: W= wholesalers, R=Retailers, SR=Sub retailers. Interest (profit) per day = Sales Price (S.P.) - Cost Price C.P.)

N.B. 1\$ (USD) = Rs. 45 in the year 2009-2011.

Table 7: Daily Profit of wholesalers, retailers and sub-retailers (vendors) for *Allium hookeri* in the plain and Hill districts of Manipur

Mean ± standard deviation				
Profits of the Markets of the plain districts of Manipur			Profits of the Markets of the Hill districts of Manipur	
Wholesalers	Retailers	Sub-retailers/vendors	Retailers	Sub-retailers/vendors
Amount of <i>Allium hookerii</i> sold day ⁻¹ = (6625±610) kg	Amount of <i>Allium hookerii</i> sold day ⁻¹ = (6625±610) kg	Amount of <i>Allium hookerii</i> sold day ⁻¹ = (722±157) kg	Amount of <i>Allium hookerii</i> sold at retail rate day ⁻¹ = (600±100) kg	Amount of <i>Allium hookerii</i> sold at sub-retail price day ⁻¹ = (373±28) kg
Cost price of Wholesalers Kg ⁻¹ =Rs.80±5	Cost price of retailers Kg ⁻¹ = Rs.88±5	Cost price of sub-retailers Kg ⁻¹ = Rs. 109.62 ± 5	Cost price of retailers Kg ⁻¹ = Rs.88±5	Cost price of sub-retailers Kg ⁻¹ = Rs.112±5
Total cost price of wholesalers =Rs.533050± 81925	Total cost price of the retailers = Rs. 586050±86805	Total cost price of sub-retailers =Rs.79775 ±20760	Total cost price of the retailers = Rs.53300 ± 11800	Total cost price of the sub-retailers = Rs.41916 ± 5006
Sale price of Wholesalers Kg ⁻¹ = Rs. 88±5	Sale price of Retailers Kg ⁻¹ =Rs.(110.15 ± 5)	Sale price of Sub-Retailers Kg ⁻¹ =Rs.(125.03 ± 5)	Sale price of Retailers Kg ⁻¹ =Rs.(112±5)	Sale price of Sub-Retailers Kg ⁻¹ =Rs.(130±5)
Total sale price of wholesalers day ⁻¹ = Rs.586050 ±86805	Total sale price of the retailers day ⁻¹ = Rs. 729150±110588	Total sale price of the sub-retailers day ⁻¹ =Rs.91001±23212	Total sale price of the sub-retailers day ⁻¹ = Rs. 67700±14200	Total sale price of the sub-retailers day ⁻¹ = Rs.48630±5505
Total profit of the wholesalers day ⁻¹ = Rs.53000 ± 4880	Total profit of the retailers day ⁻¹ =Rs. 143100± 13120	Total profit of the sub-retailers day ⁻¹ =Rs. 11226 ± 2452	Total profit of the retailers day ⁻¹ =Rs. 14400± 2400	Total profit of the sub-retailers day ⁻¹ =Rs. 6714 ± 499
Total income earn on <i>Allium hookeri</i> per day in Manipur by plant gatherers, wholesalers, retailers and sub-retailers is Rs.761490 ± 105276 approximately.				
1\$ (USD) = Rs.45 in the year 2009-2011.				

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