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Research Article

A study on morphological observations and biochemical parameters of wild olive (*Elaeocarpus floribundus* Blume) grown in Manipur

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Abstract
The wild olive (*Elaeocarpus floribundus* Blume) is an underutilized fruit species that belongs to the Elaeocarpaceae family and is locally known as *Chorphon* in Manipur. The present study aimed to study morphological observations on fruit weight, fruit length, fruit width, stone weight, stone length, stone diameter, pulp weight, pulp weight: stone weight ratio and biochemical parameters i.e. total soluble solids (TSS), total sugar %, total carbohydrate, protein, ascorbic acid, total phenol, total flavonoid and oil for wild olive (*E.floribundus* Blume). Accordingly, the fruit samples were collected from 14 locations/places (S1 to S14) of Manipur varying in altitude from 292-1459m i.e. Minou, Longmai-3, Lilong, Yarou Bamdiar, Kakching, Khongman, Patsoi, Thoubal Ningombam, Komlathabi, Yaripok, Molnoi, Tokpaching, Tengnoupal and Chingai. The study showed that sample S_4 **(**Yarou Bamdiar**),** having an altitude of 777m was found to be the best among all samples studied with the highest pulp weight: stone weight ratio (6.79), second highest fruit width (32.26mm) and stone length (28.57 mm), least stone weight of 2.06 g among morphological observations and highest protein (0.65%), total carbohydrate, (2.38 mg/100g), ascorbic acid (5.51 mg/100g), total phenol (55.21 mg/100g) and oil content (14.26%) among biochemical parameters. There was a negative correlation observed between the altitude of locations of sample collection and the majority of morphological observations (-0.132 to -0.543), whereas a positive correlation was observed between altitude and the majority of biochemical parameters (0.042 to 0.293). This study emphasizes that wild olive morphotypes found in Manipur, India, are comparable in their morphological and biochemical parameters to commercial olive cultivars, and their production technology should be strengthened.

Keywords: Altitude, Biochemical parameter, Morphological observations, Oil content, Wild olive

INTRODUCTION

The olive (*Elaeocarpus floribundus* Blume) is a less exploited, underutilized fruit species that belongs to the Elaeocarpaceae family and is locally known as *Chorphon* in Manipur. Because the fruit resembles the shape of an olive, it is known as '*jalpai*' in Bengali or Indian olive. It is a medium to tall tree with plain green foliage and occasionally red or orange leaves. Flowers blossom from April through May, and greenish fruits ripen for harvest from August to October. The edible component of a seeded drupe is mesocarp around the seeds of a greenish, solitary fruit. This sour, mature, and immature fruit mostly produces chutney and pickles (Bhowmick, 2017). It is a drupe because it has a lignified endocarp (stone) containing a seed, a fleshy mesocarp that contains the oil and a thin epicarp. Olives come in a variety of forms, diameters and pulp-per-stone ratios. The primary components of olive flesh are water (60-75%) and lipids (10-25%) (Guo *et al*., 2018). The olive tree is said to have originated in Asia Minor and spread to the remainder of the Mediterranean basin some 6,000 years ago, via Iran, Syria, and

Palestine. It is grown on around 9.4 million hectares globally, yielding 20.81 million tonnes and a productivity of 2.10 t/ha (FAO, 2016).

Spain leads the way with 4.56 million tonnes produced from 2.52 million hectares, but Egypt has the highest productivity at 9.29 t/ha (FAO, 2016 ; Lal *et al.*, 2016). India meets its entire demand for olive oil through imports, primarily from Europe. As per data from the Ministry of Commerce, Government of India, the introduction of extra virgin olive oil increased by 42% in volume and over 90% in value in 2011. Olive cultivation in India is still in its infancy, with only a few patches in the states of Jammu and Kashmir, Himachal Pradesh, and Uttarakhand. The cultivars planted in India are mostly those from Egypt, Italy, and the United States (Verma *et al.*, 2012). Olive trees are important for cultivation because of their potential for conversion into edible oil and their benefits to human health. Olive oil is especially important among other edible oils because of its pleasant flavor, palatability, stability, and health benefits (Shekh *et al.*, 2019). The olive trees are subjected to diverse environmental conditions. Leaves have anticonvulsant, antioxidant, anti-inflammatory, immunomodulatory, analgesic, antibacterial, antiviral, antihypertensive, anticancer, antihyperglycemic, antinociceptive, gastroprotective and wound healing properties (Deraz *et al.*, 2022).

Fruits contain several antioxidant chemicals, including ascorbic acid, tocopherol, glutathione, and carotenoids, which may all help protect against oxidative damage. Fruits high in phenols and flavonoids are powerful antioxidants (Dey *et al.*, 2019). Pectin, organic acids, and pigments are all important components of olive fruit. Consumption of olives and olive products worldwide has expanded dramatically, particularly in high-income nations such as the United States, Europe, Japan, Canada, and Australia, resulting in the rapid creation of olive -based goods (Ghanbari *et al*. 2012). Because of the value of its oil, it is known as the "tree of liquid gold" (Kumar *et al.*, 2020). Olive oil is the most nutritious of all dietary oils. The ratio of vitamin E to polyunsaturated fatty acids is higher in this oil than in any other edible oil. (Kumar *et al.*, 2020). Because of their nutritious worth, the olive fruit and its oils are in high demand. Because of the well-balanced oil content and abundant minor components in the fruits, olive trees are unique among oil plants (Jain *et al.*, 2023). Olive oil's anti-oxidant characteristics can help to avoid diseases like coronary heart disease (CHD), stroke, and certain types of cancer (Guo *et al.*, 2018). It is well-recognized that consuming some natural antioxidants, particularly polyphenols, offers numerous health benefits. These bioactive chemicals have a high capacity for radical scavenging and can help protect against oxidative damage and cellular ageing (Tekaya *et al.*, 2022). Extra virgin olive oil's phenolic compounds play an important role in its therapeutic effects (lowering cholesterol, blood pressure, and the risk of cardiovascular disease, as well as being responsible for its oxidative stability and contributing to its organoleptic qualities). Squalene is a major component of because of its cancer-fighting abilities (Mousavi *et al.*, 2019).

The olive crop is cultivated as a commercial crop in most parts of the world but India needs to emphasize commercial cultivation. It has significant potential for contribution to national economy. In Manipur, India, no attempts have been made to cultivate wild olives due to lack of awareness and attention. As per available literature, no study has been done on morphological observations and biochemical parameters of wild olives in Manipur, India. Keeping this in mind, the present study aimed to study morphological observations and biochemical parameters of wild olive (*E. floribundus* Blume) grown in Manipur, India, from fourteen locations.

MATERIALS AND METHODS

Sample collection and experimental details

Ripened and matured wild olives (*E. floribundus* Blume) were collected from 2022-23 from 14 different locations in Manipur, varying in altitude from 292-1459m, as shown in Table 1. The collected samples were immediately transferred to the Department of Horticulture, Sikkim University, Gangtok laboratory for storage and further experiments.

Morphological parameters

All the fruit weight, stone weight, and pulp weight data was measured using an electronic weighing balance (Mettler Toledo) and expressed in grams (g). Fruit length, fruit width, and stone diameter were measured using vernier callipers (Mitutoyo) and expressed in milli meters (mm).

Biochemical parameters

Data on total soluble solids (ºBrix) were measured using a hand refractometer following the standard procedure of AOAC (1984). The total sugar and carbohydrates were determined using Anthrone reagent described by Hossain et al. (2014) and following AOAC (1984). The total protein content of samples was estimated following Lowry (1951). Ascorbic acid was estimated by following the procedure of Kapur *et al*. (2012). Similarly, total phenolic content was estimated using Folin-Ciocalteu's technique and total flavonoid content by employing the aluminium chloride colorimetric method as described by Keer *et al*. (2014). Total oil content of the samples was determined following the procedure suggested by Gurung and Manivannan (2020).

Statistical analysis

The present experiment was performed in a completely randomized design (CRD) with fourteen samples and

Table 1. Showing details of wild olives (*Elaeocarpus floribundus* Blume) collection from different places/locations of Manipur

Sample	Place/location of sample collection	Altitude (m)	Coordinates
S_1	Minou	292	24º12’34” N 94º16’33” E
S_2	Longmai-3	482	24º51’21” N 93º37’11” E
S_3	Lilong	775	24º40’48” N 93º57’16” E
S_4	Yarou Bamdiar	777	24º44’23” N 93º51’56” E
S_5	Kakching	778	24º29’05” N 93º59’52” E
S_6	Khongman	778	24º44’41” N 93º56’37” E
S_7	Patsoi	779	24º47’07” N 93º53’02” E
S_8	Thoubal Ningombam	785	24º41’44” N 94º01’21” E
S_9	Komlathabi	803	24º24’44” N 94º00’59” E
S_{10}	Yaripok	844	24º38’54” N 94º04’24” E
S_{11}	Molnoi	849	24º26’39” N 94º01’50” E
S_{12}	Tokpa Ching	1083	24º18’19” N 93º56’19” E
S_{13}	Tengnoupal	1332	24º22’57” N 94º09’05” E
S_{14}	Chingai	1459	25º18’43” N 94º30’21” E

three replications. All the collected data on morphological observations and biochemical parameters were subjected to Fisher’s test. The significance of variance was determined by employing the degree of probability at P=0.05. The data for various parameters were analyzed using OPSTAT program using single factor analysis. Karl Pearson’s coefficient of correlation was used to determine a positive or negative correlation between the altitude of places of sample collection and morphological and biochemical parameters as per the method given by Chandel (2012).

RESULTS AND DISCUSSION

Morphological observations

Table 2 shows a statistical difference among the samples regarding fruit weight and fruit length of wild olives. In the case of fruit weight, S_{13} recorded maximum weight (28.03 g) as compared to other samples followed by S_3 (24.48 g) and S_1 (27.40 g), respectively. Similarly, maximum fruit length was recorded in S_{11} (43.07 mm), which was at par with S_4 (42.80 mm) and S_2 (41.70 mm). The findings of this study regarding fruit weight and length were superior to those of Dey *et al*. (2022), Kumar *et al*. (2020) and Bhowmick (2017). This discrimination in fruit weight may be attributed to environmental conditions and maturity stage. However, in the case of fruit width, samples such as S_2 (32.31 mm), S_4 (32.26 mm), S_{11} (32.26 mm) and S_1 (31.66 mm) found to be statistically superior and at par with each other. The least fruit width was observed in S_{13} (24.44 mm). The present study's results were found similar to the findings of Raji and Siril (2021), who studied the genetic diversity of potential Ceylon olive (*E.serratus L.*) genotypes and reported fruit width ranged from 14.25 mm to 21.42 mm. Similarly, to the stone characteristics of fruits, S_{14} (5.53g) recorded maximum stone weight and was significantly different among treatments on par with S_1 (5.17g). The results of the present study regarding stone weight were higher than those recorded by Ivancic *et al*. (2022) [*Olea europaea* L. cv. Leccino at Izola, Slovenia], Kumar *et al*. (2020) [*Olea europaea* L. cultivars Nocellara Messinese and Cipressino etc. at mid hill regions of Jammu and Kashmir] and Salmani *et al*. (2016) [olive (*Olea europaea* L. cv. Kroneiki at Greece] where their recorded stone weight ranged from 0.10 g to 0.42 g.

Likewise, S_6 was statistically superior among other treatments, recording the maximum values in stone length (33.19 mm) and diameter (16.40 mm), respectively. Raji and Siril (2021) reported stone length ranging from 15.00 mm to 26.00 mm in their study on Ceylon olive (*E.serratus* L.), which was significantly lower than in the present study. Likewise, Khadivi *et al*. (2022) reported the stone length ranging between 11.28 mm and 20.78 mm in their study on olive (*Olea europaea* L.) at Gilvan area in Zanjan province of Iran. However, S_6 (16.40 mm) was found to be statistically significant and was at par with S_2 (16.04 mm) and S_1 (15.52 mm) in stone diameter. The results of these studies regarding stone diameter were significantly larger compared to Kumar *et al*. (2021) in olive (Olea europaea L.) cultivars under mid-hill regions of Jammu & Kashmir and Khadivi et al. (2022) on olive (*Olea europaea* L.) at Gilvan area in Zanjan province of Iran, respectively. Pulp weight of S_{11} was significantly superior over other samples, which recorded a maximum weight of 21.52 g followed by S_2 (18.14) and S_1 (17.62 g), respectively. The findings regarding pulp weight were superior to those of Dey *et al*. (2019), who reported pulp weight of 5.19 g. The variation in pulp weight could be attributed to geographical location and nutrient availability. The pulp weight: stone weight ratio, as presented in Table 2 shows that the highest pulp weight: stone weight ratio of 6.79 was observed in S_4 (Yarou Bamdiar) followed by 6.75 in S_{11} (Molnoi). The fruit,

Table 2. Various morphological observations of wild olive (*Elaeocarpus floribundus* Blume) grown at different locations of Manipur (Mean values of three samples each)

Samples	Fruit weight (g)	Fruit length (mm)	Fruit width mm)	Stone weight (g)	Stone length (mm)	Stone Diameter (mm)	Pulp weight (g)	Pulp weight :Stone weight
S_1	27.40	40.84	31.66	5.17	26.51	15.52	17.62	3.40
S_2	16.62	41.70	32.31	4.65	27.77	16.04	18.14	3.90
S_3	24.48	38.57	30.61	4.20	25.53	14.35	12.14	2.89
S_4	21.32	42.80	32.26	2.06	28.57	11.17	13.98	6.79
S_5	17.44	37.95	26.53	2.49	25.34	11.66	12.62	5.07
S_6	17.29	36.61	26.77	2.72	33.19	16.40	11.84	4.35
S_7	15.25	37.46	27.49	2.84	27.17	12.13	15.85	5.58
S_8	17.33	34.56	24.60	4.38	22.36	11.12	12.03	2.75
S_9	15.49	33.98	24.64	3.20	27.36	15.95	10.11	3.15
S_{10}	18.41	37.51	28.43	3.63	25.28	13.85	15.95	4.39
S_{11}	18.08	43.07	32.26	3.19	28.28	13.32	21.52	6.75
S_{12}	18.64	35.39	24.55	2.67	23.39	11.11	10.62	3.97
S_{13}	28.02	31.70	24.44	2.62	23.54	13.83	8.93	3.41
S_{14}	21.04	37.57	26.39	5.53	27.36	13.16	12.082	2.18
S.E(d) ±	0.866	0.953	0.717	0.333	0.908	0.640	0.594	
S.E(m) ±	0.613	0.674	0.507	0.226	0.642	0.453	0.420	
C.D ($p \le 0.05$)	1.784	1.963	1.477	0.686	1.870	1.318	1.223	
r	0.123	-0.518	-0.579	-0.132	-0.229	-0.337	-0.543	

For sample collection: Refer to Table 1**;** r represents coefficient of correlation between altitude of places of sample collection and morphological observation

pulp and stone samples from S_4, Yarou Bamdiar location, are shown in Plate 1. The lowest ratio of 2.18 was observed in S_{14} (Chingai). The higher pulp weight-stone weight ratio is beneficial for the extraction of olive oil.

A negative correlation was observed between altitude and the majority of morphological observations. Only a positive correlation was observed in fruit weight, i.e. 0.123. The negative correlation was observed in stone weight (-0.132), stone length (-0.229), stone diameter (-0.337), fruit length (-0.518), pulp weight (-0.543), fruit width (-0.579) in increasing order (Table 2). Strikic *et al.* (2009) also found higher morphological variability in Croatian olive cultivar 'Oblica' and they observed a negative correlation between elevation and fruit length (-0.52), fruit width (-0.56), fruit fresh weight (-0.55), endocarp length (-0.26), endocarp weight (-0.18), endocarp width (0.05). The findings of the present study are similar to the observations in Olive (*Olea europaea* L.) cv. Oblica in Croatia, as reported by Strikic *et al.* (2009).

Biochemical parameters

Table 3 shows the result of the biochemical parameters of wild olives grown at different locations in Manipur. In biochemical parameters, S_4 recorded maximum values in the majority of parameters such as total carbohydrates, protein, ascorbic acid, total phenol and oil content.

Maximum TSS was recorded in S_3 (8.30^0Brix), which was statistically superior over other treatments, followed by S_4 (7.26^0Brix), S_{11} (6.46 ^{0}Brix) and S_2 (6.43

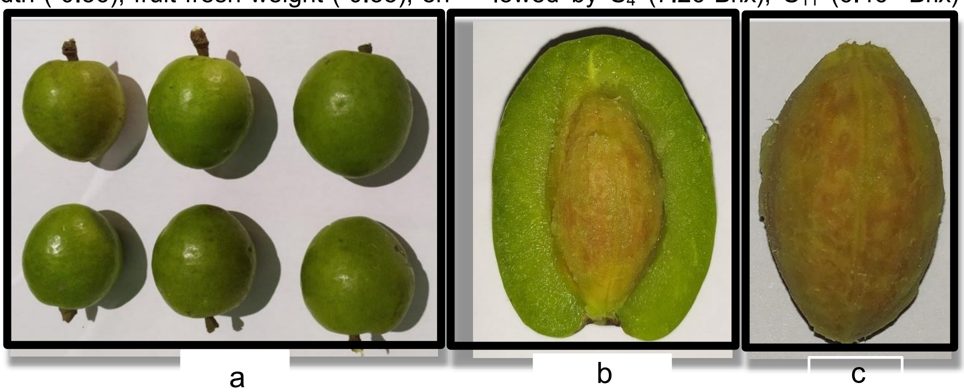

Plate 1. *S_4 fruit sample from Yarou Bamdiar, Manipur (a) Fruit of wild olive (b) Pulp and stone of wild olive (c) Stone of wild olive*

^{0}Brix), respectively. The lowest TSS was recorded in S_9 (3.10 ^{0}Brix). The current finding is similar to studies conducted by Dey *et al*. (2022), Dey *et al*. (2019) and Lima *et al*. (2019). The variation may be related to fruit maturity, and unfavourable temperature during the fruit growth and ripening stages.

However, maximum total sugar was observed and recorded in S_6 (6.33%), which was at par with S_{13} (6.20%) and S_{14} (6.00%), respectively. The lowest total sugar value was recorded in S_2 (2.96%). The results were consistent with the findings of Dey *et al*. (2022), who reported total sugar with a maximum level of 6.45%. Ghosh *et al*. (2017) also stated that the total sugar content was highest (8.34%) and lowest (7.89%), which was the result of this study. The findings of this study conform to the studies conducted by Dey *et al*. (2019), Bhowmick(2017), and Ozdemir and Kurultay (2015). Even though S_4 (2.38 mg/100g) recorded maximum total carbohydrate among other treatments, it was at par with other treatments such as S_{13}, S_6, S_9, S_7, S_{10}, respectively. The minimum total carbohydrate was observed in S_1 (1.53 mg/100g). The findings are similar to the studies conducted by Jain *et al*. (2023) and in agreement with Dey *et al*. (2019). In the case of protein, the maximum value was recorded in both S_4 (0.65%) and S_{13} (0.65%); however, these samples were found to be at par with other samples such as S_{14}, S_{11}, S_3, S_1, S_5 and S_{10}, respectively. The lowest protein was observed in S_7 (0.47%). The results were consistent with the findings of Dey *et al*. (2019), Lima *et al.* (2019) and Jain *et al*. (2023). The variations in protein may be caused by weather fluctuations, fruit growing location, soil quality, and ripening stage.

Maximum ascorbic acid was recorded in S_4 (5.51 mg/100g), significantly different from other samples followed by S6 and S10, respectively. The lowest ascorbic acid was recorded in S_1 (3.22 mg/100g). The findings of the present study are in line with those of Lima *et al*. (2019)for *E. serratus* at Dourados, Brazil, Dey *et al.* (2019) in Terai region of West Bengal, India and Ghosh *et al*. (2017) at Nadia, West Bengal, India for Indian Olive *E.floribundus* Bl. The ascorbic acid found in the present study was higher than that reported by Khomdram *et al.* (2014) for Indian Olive *E.floribundus* Bl., Manipur. The rise in ascorbic acid level up to maturity could be linked to appropriate hexose sugar supply *via* photosynthetic activity (Dey *et al*., 2022) at Mondouri, West Bengal, for Indian olive *E.floribundus* Bl. Ascorbic acid is lost later in the storage process due to the activities of phenol oxidase and ascorbic acid oxidase enzymes as report-

Table 3. Various biochemical parameters of wild olive (*Elaeocarpus floribundus* Blume) grown at different locations in Manipur

Samples	Total Soluble Solids (^{0}Bx)	Total Sugar (%)	Total carbohydrate (mg/100g)	Protein (%)	Ascorbic acid (mg/100g)	Total phenol (mg/100 g)	Total flavonoid (mg/100g)	Oil (%)
S_1	4.46	5.53	1.53	0.61	3.22	48.58	35.82	11.45
S_2	6.43	2.96	1.60	0.52	4.08	51.83	40.16	12.16
S_3	8.30	3.33	1.83	0.62	3.79	51.33	36.25	11.04
S_4	7.26	5.80	2.38	0.65	5.51	55.21	39.94	14.26
S_5	4.80	3.33	1.73	0.61	3.30	45.29	37.60	10.29
S_6	4.36	6.33	2.28	0.51	4.25	47.37	35.58	12.26
S_7	6.30	5.76	2.02	0.47	3.86	52.85	34.62	12.65
S_8	5.33	3.53	1.93	0.63	4.12	49.72	36.72	11.55
S_9	3.10	3.30	2.22	0.49	3.31	50.63	46.05	13.35
S_{10}	4.40	3.23	2.01	0.59	4.25	48.57	36.49	9.86
S_{11}	6.46	3.46	1.59	0.62	4.01	48.67	35.37	11.63
S_{12}	5.26	3.06	1.83	0.54	3.80	49.38	36.83	10.37
S_{13}	5.60	6.20	2.37	0.65	4.16	51.85	35.86	12.22
S_{14}	4.50	6.00	1.69	0.62	4.18	49.49	34.27	11.33
S.E(d) ±	0.209	0.161	0.188	0.030	0.213	0.722	1.034	0.132
S.E(m) ±	0.147	0.114	0.133	0.022	0.151	0.510	0.731	0.093
C.D ($p \leq 0.05$)	0.429	0.331	0.387	0.063	0.438	1.486	2.128	0.271
R	-0.097	0.256	0.293	0.244	0.237	0.042	-0.261	-0.111

For sample collection: Refer to Table 1; r represents the coefficient of correlation between the altitude of places of sample collection and biochemical parameters ed by Ghosh *et al*. (2017) for Indian Olive *E.floribundus* Bl. at Nadia, West Bengal, India. Therefore, changes in temperature and harvesting stage may influence fruit ascorbic acid content. S_4 was statistically superior to other samples, with the maximum total phenol content of 55.21 mg/100g. It was followed by S_{13}, S_2 and S_3, respectively and lowest total phenol was recorded in S_5 (45.29 mg/100g). The results regarding total phenol were found to be higher than Ahmadipour *et al*. (2018) (olive cultivars *Olea europaea* L.) and Dey *et al*. (2022) for Indian olive *E.floribundus* Bl. but lower as compared to the findings of Jain *et al*. (2023) and Gholami *et al*. (2022) for olive cultivars *(Olea europaea L.)* The chemical structures and levels of phenolic compounds in olives are complicated, and various factors are known to influence the phenolic profiles of olive fruits. These characteristics include cultivar and genetics, maturity, climate, tree position, rootstock, and agricultural practices (Uylaser, 2015). Likewise, the maximum total flavonoid was recorded in S_9 (46.05 mg/100g), which was statistically significant compared to other samples. It was followed by S_2 and S_4 respectively. The lowest total flavonoid was observed in S_{14} (34.27 mg/100g). The present study's findings were similar to Jain *et al*. (2023) (olive cultivars) and Lima *et al*. (2019) for *E.serratus*. In the case of oil content, maximum oil content was recorded in S_4 (14.26%) which was statistically superior over rest of the samples. The lowest oil content was observed in S_{10} (9.86%). The present finding is in accordance with Touati *et al*. (2022), who reported a range of oil content from 1.33% to 13.33% for olive cultivars and with studies conducted by Blanch *et al*. (2020), Kumar *et al*. (2020) and Bolandnazar *et al*. (2014) for olive cultivars (*Olea europaea* L.)

Positive correlation was observed between altitude and biochemical parameters in increasing order, i.e., total phenol (0.042), ascorbic acid (0.237), total protein (0.244), total sugar (0.256), total carbohydrate (0.293). However, negative correlations were observed in TSS (-0.097), oil per cent (-0.111), and total flavanoid (-0.261) in increasing order (Table 3). Papachatzis *et al*. (2020) conducted their studies on five olive fruit cultivars grown in Greece. They reported that olive fruit's total phenolic content and antiradical activity strongly depend on cultivar and altitude. In their study olive cultivars, Agrielia and Amfisis were observed to have higher total phenol content and antioxidant activity DPPH in olive orchard of higher altitude i.e. above 500m whereas cultivars Kalamon and Lefkolia Serron were characterized by high total phenol content and antioxidant activity DPPH in olive orchard of lower altitude (130m). In the present study positive correlation was observed between altitude and total phenol (0.042).

The present study showed that wild olive morphotypes found in Manipur are comparable in morphological observations and biochemical parameters to commercial olive cultivars, i.e., Oblica, Kalamon, Lefkolia Serron, Agrielia, Amfisis, Leccino, Cipressino, etc.

Conclusion

This present study observed morphological observations and biochemical parameters of wild olives grown at different locations of Manipur varying in altitude. The wild olives grown in Yarou Bamdiar (S_4) at an altitude of 777m were superior to the rest of the samples. This study identified areas for improvement that can be addressed by employing advanced breeding techniques to further promote the cultivation of this fruit in local regions as nutritional and economic boosters. The wild olive fruit holds significant potential in marketing and commercialization. However, further intensive attempts are required to bring this crop into cultivation by incorporating desirable characteristics preferred by consumers. This study emphasized that wild olive morphotypes found in Manipur are comparable in morphological observations and biochemical parameters to commercial olive cultivars, and their production technology should be strengthened. Further studies may be done on the molecular characterization of the wild olive morphotypes found in Manipur, India.

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Conflict of interest

The authors declare that they have no conflict of interest.

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