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Phytochemical and Physicochemical Assessment of *Quercus semecarpifolia* Leaves in the North-West Himalaya

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***Abstract*: Present investigation deals with to check the phytochemical and physicochemical analysis of *Quercus semecarpifolia* leaves collected from different districts (Shimla, Mandi, Kangra and Kullu) of Himachal Pradesh, India. The experiment was conducted within the laboratory of Shoolini University campus. Physicochemical and phytochemical properties of the leaves showed nonsignificant variations in five parameters (total ash, ether extract, nitrogen free extract, carbohydrates, and saponin content) and significant variations were shown in six parameters (crude fiber, acid detergent fiber, neutral detergent fiber, crude protein, tannin content and total phenols) in Mandi, Kangra and Kullu districts. *Q. semecarpifolia* is evergreen, easily available fodder tree which is a high-quality forage for livestock to fulfill the deficiency of protein and help to improve animal metabolism, health, growth, and productivity.**

***Keywords*: *Quercus semecarpifolia*, secondary metabolites, Himachal Pradesh, phytochemical analysis, physicochemical analysis.**

1. Introduction

Since primitive times, humans are using plants for his or her essential requirements like food and medicine. These plants are employed in traditional medicine to cure and forestall various human disorders. The important advantage for therapeutic use of plants includes their safety, effectiveness, economic feasibility, and easy availability [1]. Recently, the world demand for medicinal plant products has increased from USD 19.6 billion in 1996 to USD 24.2 billion in 2002 and is projected to succeed to USD 5 trillion by 2050 [2]. Among a variety of medicinal plants, species belonging to the genus *Quercus* are widely utilized in traditional medicine. Oak leaves contain plant secondary compounds. The angiosperm genus, *Quercus* (Oak) is that the most generally distributed member of the family Fagaceae [3]. Oaks are the dominant climax tree species of the moist temperate forests and occupy most of the world at mid-elevation within the Indian Himalayan Region (IHR) where about 35 species of this genus are extensively distributed between 1000 to 3500 m elevation, and most of them are evergreen fodder species. Himachal Pradesh is one of all hilly states of India, with a complete geographic region of 55673 sq. km occupying 10.5% of Himalayan landmass [4]. Agriculture and horticulture are the major occupations of this state, which became risky because of irregular productivity, insect pest attacks, crop failures, etc. caused by temperature change [5].

The evergreen trees (*Quercus semecarpifolia*) are the foremost source of feedstuffs and are available around the year, dominating the vegetation cover with a million ha of forest areas [6]. *Quercus semecarpifolia* is an evergreen 30-meter-tall tree with 12 cm long leaves with few teeth along the edges and rounded tip. *Q. semecarpifolia* Sm (Local name Kharsu) is one amongst the ecological dominant of upper temperate and sub-alpine forest of Himalayas. Oak leaves contain plant secondary compounds [6], [7]. Species of *Quercus* are important medicinal plants. Over the centuries, these species are employed in folk medicine to treat various diseases. Indigenous peoples, in many areas of the globe, use them as antiseptics and to treat epithelial duct disorders like such as diarrhea and hemorrhoids. The bark of oak has much importance and is employed extensively in medicine as an antiseptic and hemostatic, hemostatic, accustomed to cure toothache and gastropathies, and used as pacifying agent in inflammation and as healing agent in burns [8]. Oak leaves and bark are also employed in the treatment of urinary infections, cure toothache and piles, astringent, diarrhea, stomach ache cure, gonorrhea, asthma, hemorrhage, dysentery, gonorrheal digestive disorders, stomach pain, diuretic, urinary disorder, snake bite and dysentery [9]. The fruit (acorn) of the *Quercus* species is taken into account as a nutritionally rich source of energy (source of carbohydrates, proteins, and fat), justifying their use as food or ingredient food for thousands of years within the human diet like in bread production or as an ingredient for manufacturing coffee [10]. The acorns of assorted species of oak are widely employed in curing diarrhea, laryngopharyngitis disease, menorrhagia, obesity, and stomach ulcers [11], [12].

The *Quercus* genus contains various classes of compounds like glycosides, terpenoids, flavonoids, phenolic acids, fatty acids, sterols, and tannins. Despite the phylogenetic variability, phenolic acids (particularly, Gallic and ellagic acids and their derivatives), flavonoids (particularly flavan-3-ol), and tannins are abundant all told the species of *Quercus* [13]. Triterpenoids

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has also been isolated from the species of *Quercus*. Recently 3 new pentacyclic triterpenes were reported which were elucidated to be 3-O-galloyloleanolic acid, 23-acetoxy-3-O-galloyloleanolic acid, and 3acetoxy-23-O-galloyloleanolic acid together with 22 compounds known from the *Q. liaoningensis* acorn which showed antidiabetic effect [14]. The most bioactive phytochemicals are phenolic compounds, commonly found as glycosides. Other compounds that may be found in *Quercus* species are volatile organic compounds, vitamins (especially vitamin E), sterols, aliphatic alcohols and fatty acids [13], [15]. Therefore, the aim of the present investigation was to review the phytochemical and physicochemical analysis of *Quercus semecarpifolia* leaves collected from different districts of Himachal Pradesh.

2. Materials and Methods

A. Plant Materials

To assess the nutrient composition, change in leaves of *Q. semecarpifolia*, foliage was harvested from four districts (Shimla, Mandi, Kangra and Kullu). Leaf samples were collected in December, 2017. Healthy leaves were collected from healthy disease-free trees spread over the study area and random leaves were collected from all parts of the tree. Collected leaves were sun dried. Sun dried leaves were crushed in a mechanical grinder to obtain fine powder for determination of the chemical composition.

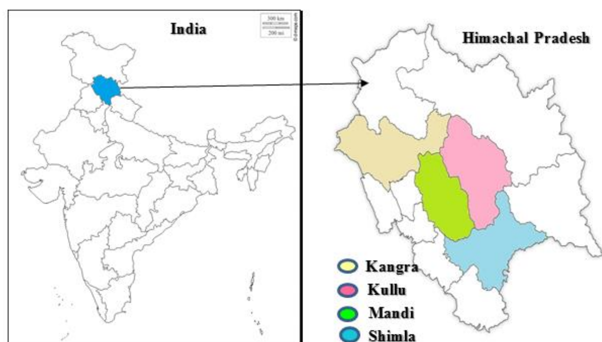

Fig. 1. Map of India showing Sample collection areas in Himachal Pradesh

B. Chemical Reagents

Sulphuric acid, Sodium hydroxide, Hcl, NaOH, Methyl orange indicator, Petroleum ether, Cetyltrimethyl ammonium bromide, Decalin, Sodium borate dehydrate, EDTA, Ethoxy ethanol, Sodium lauryl sulphate, Disodium hydrogen phosphate, Sodium sulphate, Folin-Denish reagent, Sodium carbonate, Tannic acid, Diethyl ether, Ethanol, n-Butanol, Folin-Ciocalteau, Sodium chloride, Na_2Co_3, Phosphomolybdic acid and Gallic acid.

C. Physicochemical Analysis

1) Determination of ash content

A porcelain crucible marked with a heat resistant marker were dried at 105 °C for 1 hr, left to chill in a desiccator and weighed (W1). Then 2g of the bottom sample were placed within the previously weighed crucible and reweighed (W2). The crucible with its content was then ashed first at 250 °C for an hour and at 550 °C for five hours in a muffle furnace. The samples were allowed to chill during a desiccator and then weighed (W3) [16].

$$\text{Ash content } \% = \frac{W2-W3}{W2-W1} \times 100$$

2) Determination of ether extract

5 g oven dried leaf powder was estimated with the assistance of Soxhlet's apparatus. Leaf powder was taken during a thimble of Whatman paper no. 1 and placed in an extractor. The extractor was connected with pre-weighted flask below and a condenser above. 60 ml petroleum ether with boiling point 60-80°C was poured into the extraction tube for allowing the siphon to the oil flask placed on the heater. Cold water was well-versed with the condenser during the extraction process and the extraction was applied for six hours until the liquid was as clear as clean water. The flask was then disconnected and dried until the whole evaporation of ether within the hot air oven at 100±5°C for 4-6 hours. It had been then cooled in an exceedingly desiccator and weighed to a relentless weight. The difference within the weight of the flask after and before extraction denoted the ether extract of the sample [16].

$$\text{Ether extract } \% = \frac{W2-W1}{W} \times 100$$

3) Determination of crude fiber

2 g leaf powder followed by 100 ml of 1.25% sulphuric acid solution were digested and boiled for 30 min, then filtered and stressed. The obtaining residue was then rinsed fourfold with boiling water. This process was repeated on the residue using 100 ml of 1.25% NaOH solution. The ultimate residue was then dried in an oven at 100 °C and afterward the residue cooled in an exceedingly desiccator and weighed (C1). It had been then reduced to ash in an exceedingly muffled furnace at 550 °C for five hours, then transferred to chill in an exceedingly desiccator and reweighed (C2) [16].

$$\text{Crude fiber } \% = \frac{C2-C1}{\text{Weight of original sample}} \times 100$$

4) Determination of nitrogen free extract

Nitrogen free extract were determined by subtracting the percentage of crude protein, ether extract, crude fibre and total ash on a dry matter basis [16].

$$NFE = 100 - [CP\% + EE\% + CF\% + Ash\%]$$

5) Determination of acid detergent fiber

In 1 litre 1N H2SO4, dissolved 20 g of cetyltrimethyl ammonium bromide (CTAB) for the preparation of acid detergent solution (ADS). About 1 g of leaf powder was taken during a spoutless beaker of 1 L capacity and added 100 ml acid detergent solution followed by 2 ml of decalin. The contents were refluxed for 1 hour. After refluxing, the residue was filtered through reweighed sintered glass crucibles which were washed with warm water 2-3 times followed by acetone to get

rid of all salts. The crucible containing the residue was dried in a hot air oven (100 ± 5°C) and weighed again [17].

$$\text{ADF (\%)} = \frac{(\text{Weight of crucible with residue} - \text{Weight of empty crucible}}{\text{Weight of sample taken}} \times 100$$

6) Determination of neutral detergent fiber

Neutral detergent solution was prepared by 100 ml of H_2O in an exceedingly large beaker followed by 18.61 g EDTA and 6.81 g of sodium borate dehydrated with constant heating on a hot plate until dissolved. Similarly, 30 g sodium lauryl sulphate was dissolved in 90 ml water followed by 10 ml of 2- ethoxy ethanol (ethylene glycol monoethyl ether). The mixture of sodium lauryl sulphate and 2- ethoxy ethanol was added to the previous solution. 4.56 g of disodium hydrogen phosphate (anhydrous) was taken in another beaker and 100 ml of water was added and therefore the contents were heated until dissolved. Then, it absolutely was added to the solution containing other ingredients and the volume was made up to 1 litre with water. 2 g leaf powder was taken during a 500 ml beaker followed by 100 ml of preheated neutral detergent solution (NDS), 0.5g sodium sulphite (anhydrous) and a couple of ml of decalin and therefore the contents of spout beaker were refluxed for an hour after the initial onset of boiling. The contents were washed repeatedly with warm boiling water, acetone to get rid of all salts. Then the residue was dried in a hot air oven over night at 100±5°C in an exceedingly crucible. Then cooled it and weighed to a continuing value. The crucible was kept for ashing during a muffle furnace at 550 °C for 2-3 h and the crucible together with ash was weighed again [17].

$$\text{NDF (\%)} = \frac{(Weight\ of\ crucible\ with\ cell\ well\ constituents) - (Weight\ of\ crucible)}{\text{Weight of sample taken}} \times 100$$

D. Phytochemical analysis

1) Determination of tannins

For tannic acid solution stock standard 100 mg tannic acid was added to 100 ml of distilled for tannic acid solution, stock standard 100 mg tannic acid was added to 100 ml water. For working standard, 5ml of stock solution was added in 100 ml water. 0.5 g leaf powder was taken in 250 ml of conical flask. 75 ml of water was added thereto. The mixture was heated gently and boiled for 30 min. Centrifuged solution for 20 min at 2000 rpm. Supernatant was collected. 1 ml of sample extract was transferred to a 100 ml volumetric flask containing 75 ml water. 5ml of Folin-Denish reagent and 10ml of sodium carbonate solution was added and diluted to 100 ml with water. After 30 min, the absorbance was measured at 700 nm employing a spectrophotometer. Standard graph was prepared using 0.2, 0.4, 0.6, 0.8 and 1 ml of tannic acid [16].

2) Determination of saponins

2 g of leaf powder was taken in a conical flask followed by 100 ml of 20% ethanol. Flask was heated over a hot water bath for four hours with continuous stirring at about 55°C. The mixture was filtered. Residue reextracted with another 200 ml of 20% ethanol. The combined extract was reduced to twenty ml over water bath at about 90°C. The concentrate was transferred in to 250 ml separating funnel. 20 ml diethyl ether was added and shaken vigorously. The aqueous layer was recovered while the ether layer was discarded. The purification process was repeated. 60 ml of n-butanol was added. The combined n-butanol extract was washed twice with 10 ml of 5% aqueous sodium chloride. The remaining solution was heated within a water bath. After evaporation, the samples were dried in the oven to constant weight and the saponin content was calculated [16].

$$\text{Saponin \%} = \frac{\text{Weight of residue}}{\text{Weight of sample taken}} \times 100$$

3) Determination of phenols

2 g of leaf powder was taken within 10 ml of 80% ethanol. The homogenate was centrifuged at 2,000 rpm for twenty minutes. The extraction was repeated with five times the volume of 80% ethanol. The supernatants were pooled and evaporated to dryness. The residue was then dissolved in 5 ml distilled water. Different aliquots (0.2 to 1 ml) were pipetted out and the volume in every tube was made up to 1 ml with water. Folin-Ciocalteau reagent was added followed by 2 ml of 20% Na_2CO_3 solution. The test tubes were placed in a boiling water bath for exactly one min. Phenols react with phosphomolybdic acid in Folin-Ciocalteau reagent to create a blue-colored complex in alkaline medium. The tubes were cooled and the absorbance was read at 650 nm using a spectrophotometer against a reagent blank. Standard gallic acid solutions (0.2-1 ml) corresponding to 2.0- 10 µg concentration were also treated as above. The concentration of phenols is expressed as mg/g [16].

4) Determination of crude protein

2 g leaves powders followed by 20 ml of concentrated H2SO4 were digested within a Kjeldahl flask and a digestion tablet until the mixture is vibrant. The digest was then filtered with the help of Whatman paper and made 250 ml volume and distilled. The aliquot was transferred into a 500 ml round bottom flask followed by fifty ml of 45% sodium hydroxide solution and distilled. 150 ml of the distillate were collected into a flask and 100 ml 0.1 N Hcl was added and titrated it against 2.0 mol/L NaOH using an indicator i.e., methyl orange. The end point is indicated by a color change to yellow [16].

5) Determination of carbohydrate

The total carbohydrate of the sample was calculated by adding the percentage of crude fibre and the percentage of nitrogen free extract.

$$\text{TC} = \text{CF\%} + \text{NFE\%}$$

3. Results and Discussion

A. Physicochemical Analysis

Data of physicochemical analysis is presented in Table 1 and Figure 2. Concentration of crude fiber is varied from 24.22 to 36.45%. Mandi district was observed with the highest crude fiber and the lowest crude fiber was observed from Kullu

Table 1
Physicochemical analysis of *Quercus semecarpifolia* leaves collected from different districts of Himachal Pradesh. Values were analyzed by One-way ANOVA followed by Bonferroni's Multiple Comparison Test. Individual readings were averaged (n=3)

Sr. No.	Provenance	CF (%)	AC (%)	EE (%)	ADF (%)	NDF (%)	NFE (%)
1	Shimla (Hatu Peak)	31.23	7.23	2.27	40.43	43.84	48.90
2	Mandi (Shikari Devi)	36.45	7.32	2.13	43.58	47.52	45.44
3	Kangra (Galu)	27.02	6.50	2.23	38.85	42.75	53.31
4	Kullu (Gulaba)	24.22	7.96	2.08	36.86	42.69	54.88

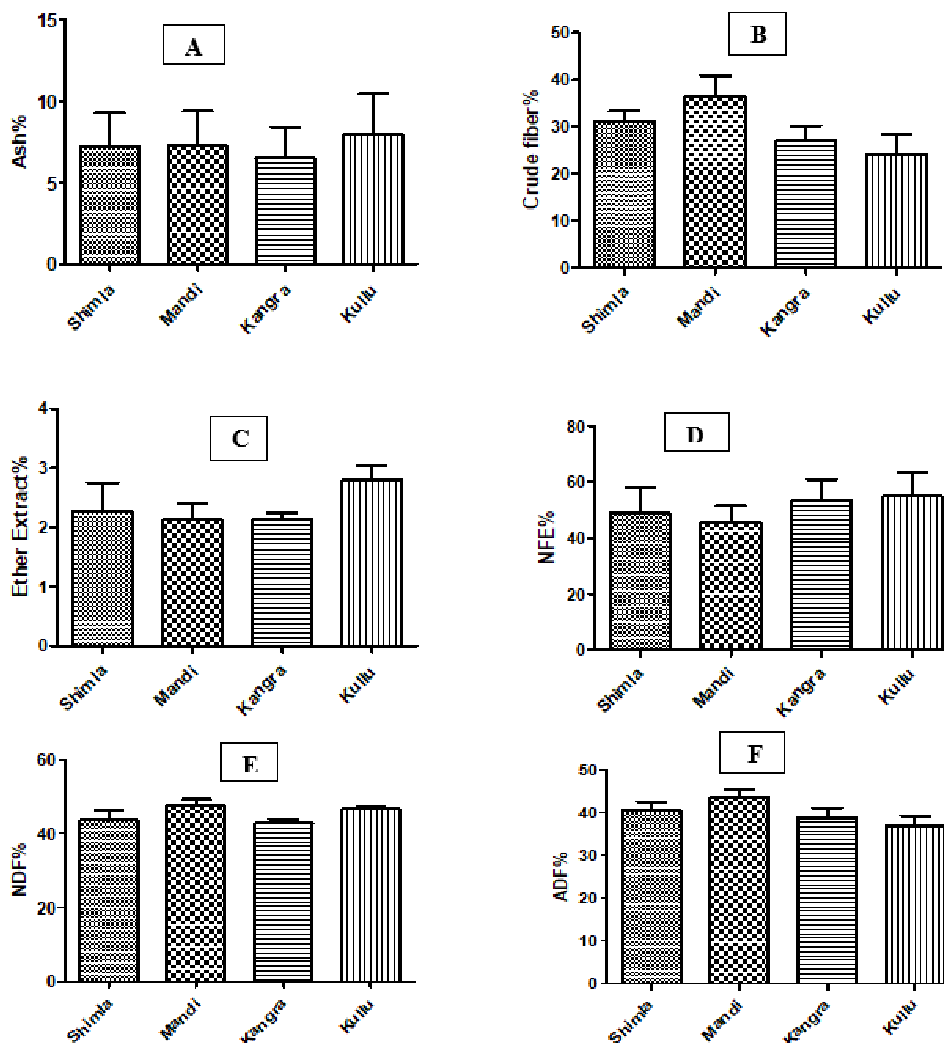

Fig. 2. 'A' Ash (%); 'B' Crude fiber (%); 'C' Ether extract (%); 'D' Nitrogen free extract (%); 'E' Neutral detergent fiber (%); 'F' Acid detergent fiber (%) in four districts of Himachal Pradesh; values were analysed by one-way ANOVA followed by Bonferroni's Multiple Comparison Test

district. Shimla, Mandi, Kangra and Kullu districts observed with crude fiber 31.23%, 36.45%, 27.02% and 24.22%, respectively. Data was subjected to ANOVA and Bonferroni's Multiple Comparison Test to examine variance in crude fiber between different districts at the significance level of $p<0.05$. Statistical analysis of different districts showed significant variation only in Mandi vs Kullu district. Concentration of ether extracts were varied from 2.08 to 2.27%. Shimla district was observed with the highest ether extract and the lowest ether extract was observed from Kullu district. Shimla, Mandi, Kangra and Kullu districts observed with ether extract 2.27%, 2.13%, 2.23% and 2.08%, respectively. Statistical analysis of different districts showed nonsignificant variation. Concentration of ash content is varied from 6.50 to 7.96%. Kullu district was observed with the highest ash content and the lowest ash content was observed from Kangra district. Shimla, Mandi, Kangra and Kullu districts observed with ash content 7.23%, 7.32%, 6.50% and 7.96%, respectively. Statistical analysis of different districts showed nonsignificant variation.

Acid detergent fiber percentage varied from 36.86 to 43.58%. Mandi district was observed with the highest acid detergent fiber and the lowest acid detergent fiber was observed from Kullu district. Shimla, Mandi, Kangra and Kullu districts observed with acid detergent fiber 40.43%, 43.58%, 38.85% and 36.86%, respectively. Statistical analysis of different districts showed significant variation only in Mandi vs Kullu district. Percentage of neutral detergent fiber is varied from 42.69 to 47.52%. Mandi district was observed with the highest neutral detergent fiber and the lowest neutral detergent fiber was observed from Kullu district. Shimla, Mandi, Kangra and Kullu districts observed with neutral detergent fiber 43.84%, 47.52%, 42.75% and 42.69%, respectively. Statistical analysis

Table 2
Phytochemical analysis of Quercus semecarpifolia leaves collected from different districts of Himachal Pradesh. Values were analyzed by One-way ANOVA followed by Bonferroni's Multiple Comparison Test. Individual readings were averaged (n=3)

Districts	Crude protein (%)	Saponin (%)	Tannin (%)	Phenol (%)	Carbohydrate (%)
Shimla (Hatu Peak)	9.78	14.63	4.34	5.86	77.70
Mandi (Shikari Devi)	8.96	13.99	3.50	4.91	78.86
Kangra (Galu)	6.67	14.35	4.40	5.71	77.90
Kullu (Gulaba)	12.08	14.15	2.39	3.35	76.81

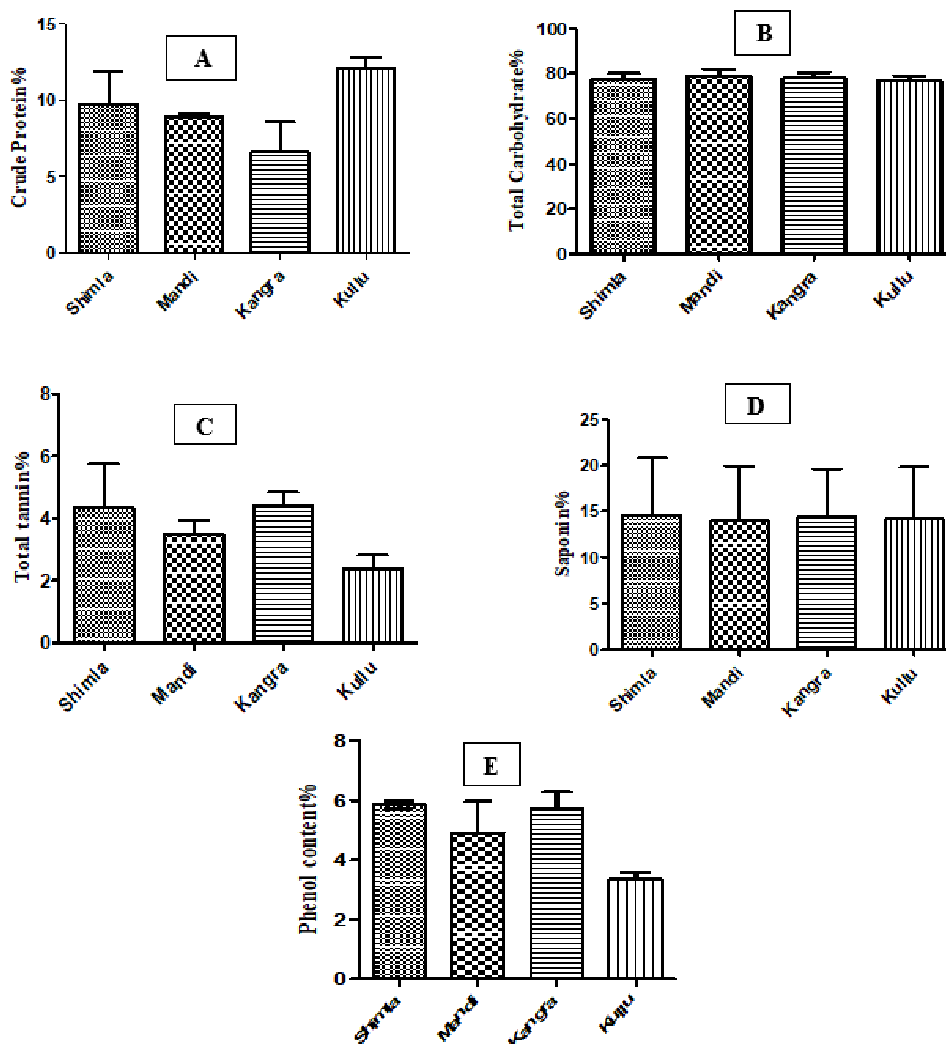

Fig. 3. 'A' Crude protein (%); 'B' Carbohydrates (%); 'C' Total tannin (%); 'D' Saponin (%); 'E' Phenol content (%) in four districts of Himachal Pradesh; values were analysed by one-way ANOVA followed by Bonferroni's Multiple Comparison Test

of different districts showed significant variation only in Mandi vs Kullu district. Percentage of nitrogen free extract is varied from 45.44 to 54.88%. Kullu district was observed with the highest nitrogen free extract and the lowest nitrogen free extract was observed from Mandi district. Shimla, Mandi, Kangra and Kullu districts observed with nitrogen free extract 48.90%, 45.44%, 53.31% and 54.88%, respectively. Statistical analysis of different districts showed nonsignificant variation.

B. Phytochemical Analysis

Data of phytochemical analysis is presented in Table 2 and Figure 3. Percentage of crude protein is varied from 6.67 to 12.08%. Kullu district was observed with the highest crude protein and the lowest crude protein was observed from Kangra district. Shimla, Mandi, Kangra and Kullu districts observed with crude protein 9.78%, 8.96%, 6.67% and 12.08%, respectively. Data was subjected to ANOVA and Bonferroni's Multiple Comparison Test to examine variance in crude protein between different districts at the significance level of $p<0.05$. Statistical analysis of different districts showed more significant variation only in Kangra vs Kullu district. Concentration of saponin content is varied from 13.99 to 14.63%. Shimla district was observed with the highest saponin content and the lowest saponin content was observed from Mandi district. Shimla, Mandi, Kangra and Kullu districts observed with saponin 14.63%, 13.99%, 14.35% and 14.15%, respectively. Statistical analysis of different districts showed nonsignificant variation. Percentage of tannin content is varied from 2.39 to 4.40%. Kangra district was observed with the highest tannin content and the lowest tannin content was observed from Kullu district. Shimla, Mandi, Kangra and Kullu

districts observed with tannin content 4.34%, 3.50%, 4.40% and 2.39%, respectively. Statistical analysis of different districts showed least significant variation in Shimla vs Kullu districts and Kangra vs Kullu districts. Concentration of phenol is varied from 3.35 to 5.86%. Shimla district was observed with the highest phenol and the lowest phenol was observed from Kullu district. Shimla, Mandi, Kangra and Kullu districts observed with phenol 5.86%, 4.91%, 5.71% and 3.35%, respectively. Statistical analysis of different districts showed more significant variation in Shimla vs Kullu districts and Kangra vs Kullu districts. Percentage of carbohydrate is varied from 76.81 to 78.86%. Mandi district was observed with the highest carbohydrate and the lowest carbohydrate was observed from Kullu district. Shimla, Mandi, Kangra and Kullu districts observed with carbohydrate 77.70%, 78.86%, 77.90% and 76.81%, respectively. Statistical analysis of different districts showed nonsignificant variation.

The present study revealed that significant variations in crude fibers, neutral detergent fibers, acid detergent fibers, tannin, crude protein and phenols and the same results were also reported earlier [18]. Crude fibers in our research is reported in range of 24.22% to 36.45% and the same results were also reported earlier [19] in both *M. azedarach* and *B. variegata* species, while [20] 18.03%, 14.67% and 5.80% crude fibre content were estimated in *Acacia nilotica*, *Morus alba* and *Salix tetragonal*, respectively. [21] 15.87% mean crude fibre content were reported in a study on 12 fodder tree species, while 17.3% crude fibre content was recorded in *G. optiva* [22], which is slightly lower from the results of our study. 8.64%, 15.22%, 9.84%, 8.84% and 6.38%, ash content were also reported in *A. catechu*, *F. religiosa*, *G. optiva*, *L. leucocephala* and *S. alba* respectively [23] similarly 5.86% ash content in *B. variegata* and 8.90% ash content in *M. azedarach* [19] and 8.64%, 15.22%, 9.84%, 8.84% and 6.38%, ash content in *A. catechu*, *F. religiosa*, *G. optiva*, *L. leucocephala* and *S. alba* respectively were estimated [23] which is in line with findings of present study. *Celtis australis*, *Morus multicaulis* and *Salix viminalis*, were observed with 21.22%, 18.46% and 10.44% total ash content [24] which was found to be higher than that observed in the present study.

Ether extract content in the range of 2.52-6.45% in *A. lebbeck*, *A. nilotica, G. optiva*, *M. azedarach* and *M. alba* were estimated [2] while 4.44%, 7.60% and 2.65% ether extract content in *Celtis australis*, *Morus multicaulis* and *Salix viminalis* were reported [24] which is slightly on higher side than the range observed in the present study. Ether extract content between the ranges of 2.09-3.29% were also estimated in *Q. semecarpifolia* leaves [25] whereas 3.81% mean ether extract content was observed in *Pittosporum floribundum* [26] which is in line with the findings of the present study. In present study, acid detergent fiber was observed between ranges of 36.86% to 43.58% and the same results were also reported earlier in *Grewia oppositifolia* (30%), *Morus alba* (24%), *Celtis australis* (22%), *Celtis caucasica* (34%), *Olea ferruginea* (39%) and *Quercus incana* (38%) [27]. 41.77%, 40.30%, 35.46%, 24.26%, 28.92% and 46.49% neutral detergent fiber content were reported in *Albizia lebbeck*, *Bauhinia variegata*, *Grewia optiva*, *Melia azederach*, *Morus alba* and *Salix alba* respectively [23], which is in conformity with result obtained in present study while, 30.67% mean neutral detergent fibre content was recorded in *Pittosporum floribundum* [31] which is slightly on lower side than the range observed in the present study.

Nitrogen free extract content in the present study is more or less in conformity with that reported by other authors in the past. 57.2% nitrogen free extract of *Bauhinia variegata* was recorded slightly on the higher side than the range is observed in the present study [19]. This may be due to variation in CP, CF, ash and EE content. Nitrogen free extracts in the range of 38.60-63.69% were also recorded in five fodder tree species [22] while 41.04%, 51.04% and 59.38% nitrogen free extract was estimated in *Acacia nilotica*, *Morus alba* and *Salix alba*, leaves respectively [20], which is in agreement with the results of the present study. 15.1% and 8.9% crude protein was observed in *Olea europea* and *Celtis africana*, respectively [29]. Crude protein content in three *Quercus* species in the range of 9-11% were reported [33], which are similar to the values reported in our study. The saponins contents were studied by different workers in the past. Presence of saponins in *Bauhinia purpurea* and *Bauhinia racemosa* leaves were reported [35]. 0.11-0.228 mg/ml saponin content in eight *Acacia* species were estimated [36]. Tannin content in present study reported between ranged of 2.39%-4.40%. Tannin content of the present study was in line with that observed by different workers. 14.6%, 3.7%, 2.9% and 2.1% tannin content was reported in *Acacia nilotica*, *Bauhinia variegata*, *Ougienia oojeiuealis* and *Leucaena leucocephala* respectively [37], which is in line with the findings of present study. Tannin content between 0.30- 0.53% were recorded [38] in three cultivars of *Morus alba*.

Phenols in our research are ranged between 3.35%-5.86%, which is in conformity with results reported earlier [37] in *Acacia nilotica* (16.2%), *Bauhinia variegata* (4.8%), *Ougienia oojeiuealis* (4.2%) and *Leucaena leucocephala* (4.9%). 0.24mg/gm phenol content was recorded in *Olea hochstteteri* [39]. 7.87±0.81% polyphenol content in *Albizia chinensis* was recorded [40]. 1.4% phenol content in *Celtis africana* [41] and 7-10% phenol content in three *Quercus* species [33] were recorded. Carbohydrates in our study are ranged between 76.81%-78.86%. The literature study also revealed a wide variation in the carbohydrate content. 47%-56% total carbohydrate content were reported in two mulberry varieties [38] which is slightly lower from the present findings. Whereas, 80.2% total carbohydrate content in *Quercus leucotrichophora* was observed [28]. It was reported that carbohydrate content decreased with maturity in *Quercus semecarpifolia* [25].

4. Conclusion

Oak leaves contain plant secondary compounds and they are a rich source of energy due to the presence of carbohydrates and proteins. *Quercus semecarpifolia* leaf harvesting during winter season offers considerable potential as high-quality forage for livestock to fulfill the deficiency of protein and help to improve animal metabolism, health, growth, and productivity. Tannins,

phenols and saponins reported from *Quercus* leaves have been implicated in various pharmacotherapeutic effects. Physicochemical and phytochemical properties of *Quercus semecarpifolia* leaves showed both significant and non–significant variation. Variation was observed only in crude fiber, neutral detergent fiber, acid detergent fiber, crude protein, tannin content and total phenol, which concluded that these properties could be responsible for the variation in the chemical profile of *Quercus semecarpifolia* with other unknown ecological factors.

Conflict of Interest

The authors declare that they have no conflicts of interest.

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References

[1] Bharti VK, Malik JK, R. C. Gupta RC. Ashwagandha: multiple health benefits, in Nutraceuticals. Academic Press, Cambridge, MA, USA. 2016.

[2] Tee LH, Yang B, Nagendra KP, Ramanan RN, Sun J, Chan ES, Tey BT, Azlan A, Ismail A, Lau CY, Jiang Y. Nutritional compositions and bioactivities of *Dacryodes* species: A review. Food chemistry. 2014; 165: 247-55.

[3] Vinha AF, Barreira JC, Costa AS, Oliveira MB. A new age for *Quercus* spp. fruits: review on nutritional and phytochemical composition and related biological activities of acorns. Comprehensive Reviews in Food Science and Food Safety. 2016; 15(6): 947-81.

[4] Verma KS, Bhardwaj DR, Krishan C. Agroforestry systems in Himachal Pradesh. Agroforestry: systems and practices. 2007:67-93.

[5] Sarwar M, Khan MA, Iqbal Z. Status paper feed resources for livestock in Pakistan. Int. J. Agric. Biol. 2002; 4(1): 186-92.

[6] Raju J, Sahoo B, Chandrakar A, Sankar M, Garg AK, Sharma AK, Pandey AB. Effect of feeding oak leaves (*Quercus semecarpifolia* vs *Quercus leucotrichophora*) on nutrient utilization, growth performance and gastrointestinal nematodes of goats in temperate sub-Himalayas. Small Ruminant Research. 2015; 125: 1-9.

[7] Guha B, Arman M, Islam MN, Tareq SM, Rahman MM, Sakib SA, Mutsuddy R, Tareq AM, Emran TB, Alqahtani AM. Unveiling pharmacological studies provide new insights on *Mangifera longipes* and *Quercus gomeziana*. Saudi Journal of Biological Sciences. 2021; 28(1): 183-90.

[8] Khennouf S, Amira S, Arrar L, Baghiani A. Effect of some phenolic compounds and *Quercus* tannins on lipid peroxidation. World Applied Sciences Journal. 2010; 8(9): 1144-9.

[9] Chauhan PS, Bisht S, Ahmed S. Traditional and ethnobotanical uses of medicinal trees in district Tehri Garhwal (Western Himalayas). International Journal of Ayurvedic and Herbal Medicine. 2017; 7(1): 2442-8.

[10] García-Gómez E, Pérez-Badia R, Pereira J, Puri RK. The Consumption of Acorns (from *Quercus* spp.) in the Central West of the Iberian Peninsula in the 20th Century. Economic Botany. 2017; 71(3): 256-68.

[11] Kim H, Song MJ, Potter D. Medicinal efficacy of plants utilized as temple food in traditional Korean Buddhism. Journal of Ethnopharmacology. 2006; 104(1-2): 32-46.

[12] Moon HR, Chung MJ, Park JW, Cho SM, Choi DJ, Kim SM, Chun MH, KIM IB, Kim SO, Jang SJ, Park YI. Antiasthma effects through anti-inflammatory action of acorn (*Quercus acutissima* carr.) in vitro and in vivo. Journal of Food Biochemistry. 2013; 37(1): 108-18.

[13] Vinha AF, Barreira JC, Costa AS, Oliveira MB. A new age for *Quercus* spp. fruits: review on nutritional and phytochemical composition and related biological activities of acorns. Comprehensive Reviews in Food Science and Food Safety. 2016; 15(6): 947-81.

[14] Xu J, Wang X, Yue J, Sun Y, Zhang X, Zhao Y. Polyphenols from acorn leaves (*Quercus liaotungensis*) protect pancreatic beta cells and their inhibitory activity against α-glucosidase and protein tyrosine phosphatase 1B. Molecules. 2018; 23(9): 2167.

[15] Lämke J, Unsicker SB. Phytochemical variation in treetops: causes and consequences for tree-insect herbivore interactions. Oecologia. 2018; 187(2): 377-88.

[16] A.O.A.C., Animal Feeds. In: Official Methods of Analysis, Vol. I, 6th edition. VA. 1995.

[17] Goering HK, Van Soest PJ. Forage fiber analysis. Agricultural handbook no. 379. US Department of Agriculture, Washington, DC. 1970: 1-20.

[18] Kumar N, Toky OP. Variation in chemical contents of seed, and foliage in Albizia lebbek (L.) Benth. of different provenances. Agroforestry Systems. 1994; 25(3): 217-25.

[19] Prakash B, Dhali A, Das KC, Rathore SS, Hazarika H, Rajkhowa C. Nutrient composition and in situ degradability of forest foliages consumed by mithun (*Bos frontalis*). Animal Nutrition and Feed Technology. 2008; 8(2): 175-83.

[20] Sheikh GG, Ganie M, Ganie AA. Nutritional evaluation of some tree leaves, feeds and fodders of Ladakh. Indian Journal of Animal Nutrition. 2011; 28(4): 427-31.

[21] Wankhede A, Jain RK. Nutritional evaluation of some tree leaves of Chhattisgarh Plain. Indian Journal of Animal Nutrition. 2011; 28(3): 246-52.

[22] Azim A, Khan AG, Ahmad J, Ayaz M, Mirza IH. Nutritional evaluation of fodder tree legumes with goats. Animal Nutrition Institute. Asian-Australasian Journal of Animal Sciences. 2002; 15: 34-37.

[23] Singh A, Sharma RK, Barman R, Kumar R, "Nutritional evaluation of some promising top foliages. Journal of Research. 2009; 8: 116-122.

[24] Ganai AM, Bakshi MP, Ahmed MA, Matto FA. Evaluation of some top fodder foliage in Kashmir valley. Indian Journal of Animal Nutrition. 2009; 26(2): 142-5.

[25] Singh B, Todaria NP. Nutrients composition changes in leaves of *Quercus semecarpifolia* at different seasons and altitudes. Annals of Forest Research. 2012; 55(2): 189-96.

[26] Mhaiskar RM. Vegetative propagation of *Pittosporum floribundum* Wight and Arn. through cuttings under mid hill conditions of Himachal Pradesh. M.Sc. Thesis, Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan, H.P, India. 2012: 54.

[27] Yaqoob M, Javedi. Nutritional evaluation of fodder tree leaves of northern grasslands of Pakistan. Pak. J. Bot. 2008; 40(6): 2503-12.

[28] Paswan VK, Sahoo A. Feeding of oak (*Quercus leucotrichophora*) leaves and evaluation for its potential inclusion in the feeding of native heifers of Kumaon Himalaya. Tropical animal health and production. 2012; 44(8): 1931-8.

[29] Shenkute B, Hassen A, Assafa T, Amen N, Ebro A. Identification and nutritive value of potential fodder trees and shrubs in the mid Rift Valley of Ethiopa. Pakistan Agricultural Scientist's Forum. 2012; 22: 1126-1132.

[30] Khan N, Barman K, Rastogi A, Sharma RK, Yatoo MA. Chemical composition, tannin fractionation and protein binding affinity of some top foliages. Indian Journal of Animal Nutrition. 2011;28(4):421-6.

[31] Rajendra MP, Reddy MC, Reeja S. Vegetative propagation of *Pittosporum floribundum*- A lesser-known multipurpose tree species. International Journal of Agricultural Science and Research. 2012; 6: 215-220.

[32] Datt C, Datta MS, Singh NP. Assessment of fodder quality of leaves of multipurpose trees in subtropical humid climate of India. Journal of Forestry Research. 2008; 19(3): 209-14.

[33] Elahi MY. Nutritive value of Oak leaves in sheep. Pakistan Journal of Nutrition. 2010;9(2):141-5.

[34] Kanta S. *Morus serrata*, a Himalayan mulberry variety an additional feed for late age silkworm and additional crop in Dhār block of Pathankot district of Punjab. International Journal of Food, Agriculture and Veterinary Sciences. 2013; 3: 82-86.

[35] Sharanabasappa GK, Santosh MK, Shaila D, Seetharam YN, Sanjeevarao I. Phytochemical studies on *Bauhinia racemosa* lam. *Bauhinia purpurea* Linn. and *Hardwickia binata* roxb. E-Journal of Chemistry. 2007; 4(1): 21-31.

[36] Almahy HA, Nasir OD. Phytochemical and mineral content of the leaves of four Sudanese *Acacia* species. Journal of Stored Products and Postharvest Research. 2011; 2(11): 221-6.

[37] Rana KK, Wadhwa M, Bakshi MP. Seasonal variations in tannin profile of tree leaves. Asian-Australasian Journal of Animal Sciences. 2006; 19(8): 1134-8.

[38] Adeduntan SA, Oyerinde AS. Evaluation of nutritional and anti-nutritional characteristics of Obeche (*Triplochition scleroxylon*) and several Mulberry (*Morus alba*) leaves. African Journal of Biochemistry Research. 2010; 4: 175-178.

[39] Njidda AA, Olatunji EA, Raji AY. Semi-arid browse forages: Their anti-nutritive substances and in sacco neutral detergent fibre and organic matter degradability. Journal of Agriculture and Veterinary Science. 2012; 1: 21-30.

[40] Buragohain R. Screening and quantification of phytochemicals and evaluation of antioxidant activity of *Albizia chinensis* (Vang): one of the tree foliages commonly utilized for feeding to cattle and buffaloes in Mizoram. International Journal of Current Microbiology and Applied Sciences. 2015; 4: 305-313.

[41] Adedapo AA, Jimoh FO, Afolayan AJ, Masika PJ. Antioxidant Properties of the Methanol Extracts of the Leaves and Stems of *Celtis africana*. Records of Natural Products. 2009; 3(1).