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NUTRIENT AND PHYTONUTRIENT COMPOSITION OF *RHUS SEMIALATA*, AN UNDERUTILISED FRUIT OF NORTH EAST INDIA

Bidyalakshmi Loukrakpam[1], Rajendran Ananthan[1]*, and Salavath Jawahar[2]

Corresponding Author:* ***Rajendran Ananthan,* ✉ *ananthan.nin@gmail.com*

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Underutilised foods have major contribution in the food security, nutrition, health, economic and environmental services. Fruit of Rhus semialata is a underutilized food consumed in north eastern India and have great application in the traditional medicine. The study aimed to determine the nutrient and phytonutrient profiles of the fruit. The fruit had 8.13% protein, 16.70% fat, 2.86% ash, 44.91% total dietary fibre and 24.29% carbohydrate. Minerals like Fe, Ca, Zn, K, Na and P were 1.45, 183, 1.45, 452, 3.2 and 276 mg/100 g respectively. Vitamin content of fruit was 21.26 mg vitamin C, 314 µg folates, 628 µg carotenoids and 2.94 mg α-tocopherol equivalent in 100 g of sample. Total essential amino acid was 31.43 mg/100 g of protein with sulphur containing amino acids as limiting amino acid. Linoleic acid was the major fatty acid of the fruit. The fruit showed 7.5 mg/ml of IC 50 in DPPH assay, 1226 mmol ferrous sulphate equivalent/100 g in FRAP assay, 229 µmol ascorbic acid equivalent and 100 µmol trolox equivalent/g of sample for water and lipid extracts respectively in superoxide anion radicle scavenging assay. Gallic acid was the most abundantly found individual polyphenol analysed. Considering the presence of both primary and secondary metabolites, Rhus semialata could be a potential underutilised food source in terms of nutrients and phytonutrient application.

Keywords: *Rhus semialata*, Underutilised fruit, Nutrient profile, Phytonutrient profile

INTRODUCTION

Only three food crops (wheat, rice and maize) provide the majority of the plant derived calories in the world, reflecting the dependence on a very limited number of crop species for human nutrition (Collins and Hawtin, 1999). Measures to improve food security by solely focussing on the productivity of current major crops, which are often selected and developed under high intensity agriculture, have not been successful to face the challenge of food insecurity and potentially makes agriculture even more vulnerable to future biotic and abiotic stresses. This narrowing of food supply base has led to the continuing existence of the micro nutrient deficiencies and increase rate of obesity and non communicable diseases linked to lack of dietary diversity (Kant *et al.*, 1995; Bourne *et al.*, 2002; and Popkin, 2002).

Underutilized or neglected crops are plant species that are indigenous, rather than non-native or adapted introductions, and which often form a complex part of the culture and diets of the people who grow them. These crops have the potential to play a number of roles in the improvement of food security by being a source of income for the growers, reducing the risk of over-reliance on very limited numbers of major crops, contributing to food quality and preserving cultural and dietary diversity.

The north-eastern region of India is an integral part of the Indo-Burma centre of biodiversity hotspot of global

[1] National Institute of Nutrition, ICMR, 500007, India.

[2] Regional Occupational Health Centre (Southern), ICMR, 562110, India.

significance (Myers *et al.*, 2000). The local communities of this region have rich ethnobotanical and traditional knowlegde of plants which is the outcome of many hit and trials selection of plants for consumption or traditional healing of various ailments. We have reported the nutritional values of many indeginous foods consumed in the northeast India recently (Chyne *et al.*, 2019; and Bidyalakshmi *et al.*, 2019). One of these plants which the people have been using both for food and therapeutic over the ages is *Rhus semialata*.

Rhus semialata (Anacardiaceae) is a deciduous tree (syn. *R. chinensis* Mill.; *R. javanica* Linn.) found in the outer Himalayan ranges at an altitude of 3,000-7,000 ft, the hills of north eastern states of India (Bhattacharjee, 1998; and Gurung, 2002), upper Burma, China and Japan (Kiritikar and Basu, 1987). The fruting period is from December to April (Singh *et al.*, 2014). The fruits along with the seeds are edible with sharp acidic taste. The infusion of fruits is traditionally used to control certain ailments like diarrhoea and dysentery. The powder of the fruit mixed with egg is also given in kidney trouble, urinary complaint due to the stone (Lokendrajit *et al.*, 2011). Despite of its role as food and in therapeutic uses, there is lack of data on the complete nutrient and phytonutrient profiles of *R. semialata* fruit. Therefore, the study was carried out to determine the proximate composition, mineral content, vitamins, amino acids, fatty acids, antioxidant activity and total phenolic and individual polyphenol content in the fruit.

MATERIALS AND METHODS

Sample Collection and Processing

The fruits of *Rhus semialata* (Figure 1) were collected from the local area of Imphal, Manipur, India. About 500 g of the fresh sample was homogenised with liquid nitrogen and stored at -80 ºC until used for further analysis. Nutrient composition such as proximate composition, minerals, vitamins, amino acids and fatty acids composition and phytonutrients namely Total Phenolic Content (TPC), individual polyphenols and antioxidant activities were carried out.

Figure 1: Pictures of *Rhus semialata* – A. Plant with the Fruits, B. and C. Matured Fruits

Methods for Analysis

Nutrient Profile

The methods of Association of Official Analytical Chemists (AOAC, 2005 and 2012) were used to determine the proximate composition. Moisture content (AOAC 934.01) was derived from the difference of the fresh weight of the samples and their dry weight (dried at 60 °C). Protein values were calculated from the estimated nitrogen (Kjedahl method) in the food using Jones conversion factor, i.e., 6.25 (Jones, 1941; and AOAC, 2001). The total fat content of the samples was determined by gravimetric method using a mixed solvent of chloroform and methanol (AOAC 963.15). Ash content was determined by gravimetric method (AOAC 942.05). The total, insoluble and soluble dietary fiber was determined using enzymatic-gravimetric method (AOAC 991.43). Finally, carbohydrate content was calculated by difference (Greenfield and Southgate, 2003). All the values are expressed in fresh weight basis.

Analysis of water soluble vitamins such as vitamin C (Phillip *et al.*, 2010), B6 (Valls *et al.*, 2001), B5 (Woollard *et al.*, 2000), B9 (Brouwer *et al.*, 2008) was carried out using Ultra-High Performance Liquid Chromatography. Individual carotenes and xanthophylls analysis was carried out using HPLC method (Rodriguez-Amaya and Kimura, 2004) and total carotenoids was estimated by taking the absorbance at 450 nm (Deepa *et al.*, 2007) using spectrophotometer. Vitamin E was quantified by normal phase U-HPLC (McMurray *et al.*, 1980; and Bonvehi *et al.*, 2000) and the value was expressed as α-tocopherol equivalent (WHO/FAO, 2002).

Elemental analysis was carried out after wet digestion according to AOAC (968.08) method. Potassium, iron, calcium, copper, manganese, magnesium, sodium and zinc were determined in atomic absorption spectrometer (flame furnace). Phosphorus was estimated by the modified Fiske and Subbarow method as described in AOAC method (995.11). And other trace elements like lithium, chromium, cobalt, nickel, arsenic, selenium, molybdenum, cadmium, antimony, mercury and lead were analysed by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) (AOAC, 2013.06) and expressed in µg/100 g of sample weight.

For amino acid analysis, the sample was hydrolysed with 6 N hydrochloric acid in a sealed tube under vacuum at 110 °C for 22 hour. And it was quantified using Automated Amino acid Analyser (Biochrom, UK) which is a cation exchange chromatographic system coupled with a highly specific detection system at 570 and 440 nm using post column derivatization with ninhydrin reagent. The samples were oxidized using formic acid and performic acid before hydrolysis for quantifying methionine and cysteine (AOAC 994.12; and AOAC 985.28). The amino acid tryptophan was determined by alkaline hydrolysis of the sample at 110 ºC with barium hydroxide octahydrate followed by HPLC separation and quantization by Fluorescence Detection (Landry and Delhaye, 1992). Chemical score of amino acids was calculated using the FAO/WHO (2007) reference pattern and the limiting amino acid was determined.

The fatty acid composition of the sample was determined as the methyl esters of fatty acids (FAMEs) by Gas-Liquid Chromatography (GC) with Flame Ionization Detector (FID). FAMEs are derived from lipids of the samples by direct acid-catalyzed (H_2SO_4) esterification method (AOAC 996.06; AOAC 996.01; and AOAC, 2012.13). SP 2560 (75 m x 0.18 mm x 0.14 µm) was procured from Sigma Aldrich and used with the detector maintained at 260 ºC.

Phytonutrient Profile

Antioxidant activity was measured using three different methods namely, reducing power by FRAP (Benzie and Strain, 1999); free radical scavenging by DPPH (Krings and Berger, 2001); and scavenging of superoxide anion radicals using the instrument PHOTOCHEM from Analytikjena (Popov and Lewin, 1999). Total phenolic content was determined by Folin Ciocalteu method (Singleton *et al.*,1999) and expressed in Gallic Acid Equivalent (GAE) per 100 g of the sample. For the above assays, the sample was analysed for two different extracts, i.e., water extract (water soluble) and methanol extract (lipid soluble). One gram of the sample was extracted with 10 ml of the respective medium (water or methanol).

For quantification of individual polyphenol, standard mix consisting of gallic acid, protocatechuic acid, chlorogenic acid, vanillic acid, p-hydroxybenzoic acid, caffeic acid, sinapic acid, ferulic acid, p-coumaric acid, o-coumaric acid, rutin, daidzein, apigenin, catechin, luteolin-7-o-glucoside, ellagic acid, myricetin, hesperetin, quercetin, luteolin and kaempferol were used to quantify them in the sample with reference to Sakakibara *et al.* (2003) by HPLC technique. Sample was extracted using 90% methanol and 0.5% acetic acid solution. The separation was carried out using Dionex C18 column (100 mm x 2.1 mm x 2.1 µm) at 30 °C. The components were identified through Diode Array Detector (DAD) at the wavelengths of 250, 280, 320 and 370 nm.

Statiscal Analysis

The data presented for various parameters were the mean of three determinations and its standard deviation.

RESULTS AND DISCUSSION

Nutrient Profile

The proximate composition and vitamins content of *Rhus semialata* fruit are given in Table1. The fruit of *R. semialata* was found to have 8.13% protein, 16.70% fat, 2.86% ash, 44.91% total dietary fibre which are very much higher than the common fruits consumed by the Indian population (Longvah *et al.*, 2017). Seal and Chaudhuri (2014) also reported protein value of 7.86% for the same fruit and Sharma *et al.* (2015) reported only 3.9% of protein. The fruit had insoluble and soluble dietary fiber of 43.96 and 0.95% respectively. It also has 24.29% carbohydrate with a moisture content of 3.11%. Its carbohydrate content was comparable to those common fruits like banana and custard apple (Longvah *et al.*, 2017). The fruit of *Rhus semialata* had an energy value of 283 kcal/100 g which was much higher than energy content of the fruit reported by Sharma *et al.* (2015).

Vitamins are a broad group of organic compounds essential for maintaining normal cellular and metabolic functions of human and animal body. Vitamin C, carotenoids and vitamin E are known to have antioxidant properties. Vitamin C is an important water soluble vitamin supplied by fruits and vegetables in the human diet. *Rhus semialata* was found to have 21.26 mg/100 g of fruit which is on par of the fruits such as musk melon, sapota, wood apple and mango varieties (Longvah *et al.*, 2017). In this study the fruit was anlaysed for different B vitamins which are widely distributed in foods and function as coenzymes that help the body obtain energy from food (Bellows *et al.*, 2012). The fruit of *R. semialata* was found to have 0.16 mg of total B6, 0.161 mg of B5 (pantothenic acid) and 314 µg of B9 (total folate). It also contained 628 µg of total carotenoids in 100 g of edible portion. The fruit also showed 5.80, 1.81 and 0.61 µg/100 g of lutein, zeaxanthin and β-carotene content respectively. Vitamin E of the fruit was 2.94 mg α-tocopherol equivalent (α-TE) per 100g of the sample.

More than twenty two minerals are required for the maintenance of health and proper organ function. While some are required in large amount (macrominerals), others such as Fe, Zn, Cu, Mn are required in trace amounts (Welch and Graham *et al.*, 2004). A total of twenty minerals were anlaysed for the fruit of *Rhus semialata*. Among the macro minerals, the fruit was found to have 452, 183, 89.32. 3.2 and 276 mg/100 g of K, Ca, Mg, Na and P respectively. The Ca and P content of the fruit was higher than tamarind pulp which had highest content of these two elements among the commonly consumed Indian fruits (Longvah *et al.*, 2017). The fruit also contained 1.45 mg of Fe, 1.45 mg of Zn, 0.65 mg of Mn and 0.15 mg of Cu in 100 g of sample. The iron content (1.45 mg/100 g) of the fruit is comparable with other common fruits namely black currant (1.36 mg) and gooseberry (1.25 mg) (Longvah *et al.*, 2017). For the other elements analysed the fruit was found to contain 2.36, 0.54, 257, 3.12, 13.22, 4.2, 0.65, 3.25, 234, 2.63 and 0.41 µg/100 g of As, Cd, Cr, Co, Pb, Li, Hg, Mo, Ni, Se and Sb respectively. The fruit content of Co, Pb, Li, Mo, Ni and Se was within the range of its respective minerals found in the commonly consumed Indian fruits. Whereas As and Cr content of the

Table 1: Proximate Composition and Vitamins Content of *Rhus semialata*

Parameters	Values
Moisture	3.11 ± 0.48%
Protein	8.13 ± 38%
Fat	16.7 ± 0.18 %
Ash	2.86 ± 0.02 %
Total dietary fiber	44.91 ± 0.49%
Insoluble dietary fiber	43.96 ± 0.44%
Soluble dietary fiber	0.95 ± 0.10%
Carbohydrate	24.29 ± 0.95%
Energy	283 ± 23 kcal/100 g
Vitamin C	21.26 ± 0.01 mg/100 g
Total B6	0.16 ± 0.02 mg/100 g
Pantothenic acid (B5)	0.161 ± 0.04 mg/100 g
Total folate (B9)	314 ± 18 µg /100 g
α-tocopherol equivalent (α-TE)	2.94 ± 0.02 mg/100 g
Total carotenoids	628 ± 9.02 µg/100 g
Lutein	5.80 ± 0.54 µg/100 g
Zea xanthin	1.81 ± 0.03 µg/100 g
β carotene	0.61 ± 0.01 µg/100 g

Note: Each value in the table was obtained by calculating the average and standard deviation of triplicate determinations.

Table 2: Minerals Content of *Rhus semialata*

Minerals	Values
Potassium	452 ± 11 mg/100 g
Calcium	183 ± 5.02 mg/100 g
Magnesium	89.32 ± 1.23 mg/100 g
Sodium	3.2 ± 0.67 mg/100 g
Phosphorous	276 ± 6.56 mg/100 g
Iron	1.45 ± 0.42 mg/100 g
Zinc	1.45 ± 0.32 mg/100 g
Manganese	0.65 ± 0.01 mg/100 g
Copper	0.51 ± 0.02 mg/100 g
Arsenic	2.36 ± 0.67 µg/100 g
Cadmium	0.54 ± 0.003 µg/100 g
Chromium	257 ± 4.56 µg/100 g
Cobalt	3.12 ± 0.76 µg/100 g
Lead	13.22 ± 1.34 µg/100 g
Lithium	4.2 ± 0.89 µg/100 g
Mercury	0.65 ± 0.04 µg/100 g
Molybdenum	3.25 ± 0.99 µg/100 g
Nickel	234 ± 14.23 µg/100 g
Selenium	2.63 ± 0.89 µg/100 g
Antimony	0.41 ± 0.04 µg/100 g

Note: Each value in the table was obtained by calculating the average and standard deviation of triplicate determinations.

fruit was at the higher side when cpmpared to common fruits (Longvah *et al.*, 2017).

Amino Acid Composition

Amino acids are biomolecules which are the building blocks of proteins and also serve as intermediates in various metabolic pathways. The quality of dietary protein is assessed from its essential to nonessential amino acid ratio. High quality proteins are readily digestible and contain the dietary Essential Amino Acids (EAA) in quantities that correspond to human requirements (WHO, 2007). The amino acid composition of *Rhus semialata* is given in Table 3. A total of eighteen amino acids were determined including the nine essential amino acids, i.e., lysine, methionine, threonine,

Table 3: Amino Acids Composition of Fruit *Rhus semialata*

Amino Acids	Values (g/100 g Protein)
Tryptophan	1.21 ± 0.03
Aspartic acid	10.87 ± 0.07
Threonin	4.21 ± 0.04
Serine	6.65 ± 0.08
Glutamic acid	18.19 ± 0.12
Proline	4.56 ± 0.06
Glycine	5.32 ± 0.09
Alanine	7.33 ± 0.06
Cystine	1.19 ± 0.01
Valine	4.74 ± 0.04
Methionine	0.43 ± 0.001
Isoleucine	3.29 ± 0.03
Leucine	5.75 ± 0.02
Tyrosine	2.25 ± 0.04
Phenylalanine	3.14 ± 0.05
Histidine	2.42 ± 0.08
Lysine	6.43 ± 0.09
Arginine	7.12 ± 0.07
Total Amino acids	95.1
Total Essential Amino acids	31.43
Amino acid Score	65
Limiting Amino acid	CYS & MET

Note: Each value in the table was obtained by calculating the average and standard deviation of triplicate determinations.

tryptophan, histidine, leucine, isoleucine, valine, and phenylalanine. The sulphur containing amino acids, cysteine (1.19 g/100 g protein) and methionine (0.43 g/100 g protein) were found to be limiting amino acids with an amino acid score of 65. The total amino acids content was 95.10 g/100 g protein and total essential amino acids was 31.43 g/100 g of protein which is 33% of the total amino acid content. The fruit had the highest content of glutamic acid (18.19 g/100 g protein) followed by aspartic acid (10.87 g/100 g protein).

The essential amino acid in the fruit is comparable to peanut (37%) (Bodwell and Hopkins, 1985). The tryptophan, threonine, valine, isoleucine and leucine content of the fruit is similar to that of Manila tamarind reported by Longvah *et al.* (2017). The content of non-essential amino acids like serine, proline, glycine, alanine, tyrosine and arginine were 6.65, 4.56, 5.32, 7.33, 2.25 and 7.12 g/100 g protein respectively. These non-essential amino acid values were comparable to its respective amino acid content of common fruits of India (Longvah *et al.*, 2017).

Fatty Acid Composition

Fatty acids are required in human nutrition as a source of energy, and for metabolic and structural activities and they also constitute as the main components of dietary lipid entities. Dietary fatty acids have been categorised into three classes based on the degree of unsaturation; Saturated Fatty Acids (SFA) have no double bonds, monounsaturated fatty acids (MUFA) have one double bond and polyunsaturated fatty acids (PUFA) have two or more double bonds (FAO, 2008). Table 4 represented the fatty acid profile of the fruit of *Rhus semialata* and values are expressed as the percentage of the total fatty acid. It had 35.90% total saturated fatty acids, 13.81% mono saturated fatty acids and 50.29% polyunsaturated fatty acids of the total fatty acid content. The fruit also had myristic and linoleic fatty acids as the major fatty acids, i.e., 30.11 and 47.55% respectively. The saturated fatty acids content of the fruit were 0.23, 30.11, 0.53, 3.53, 0.63, 0.47, 0.40% total fatty acid of caproic, myristic, palmitic, stearic, arachidic, behenic and lignoceric respectively. The three mono unsaturated fatty acids were Palmitoleic (1.66%), cis-10 heptadecanoic (0.43%) and oleic (11.72%). The polyunsaturated fatty acids observed in the fruit were linoleic (47.55%), gamma linolenic (0.16%) linolenic (2.21%) and eicosatrienoic (0.37%). The fruit had high degree of unsaturated fatty acids which was similar to the previous observation reported in *Rhus typhina* and *Rhus coriaria* (Kossah *et al.*, 2009; and Demchik *et al.*, 2015).

Table 4: Fatty Acid Composition of *Rhus semialata*

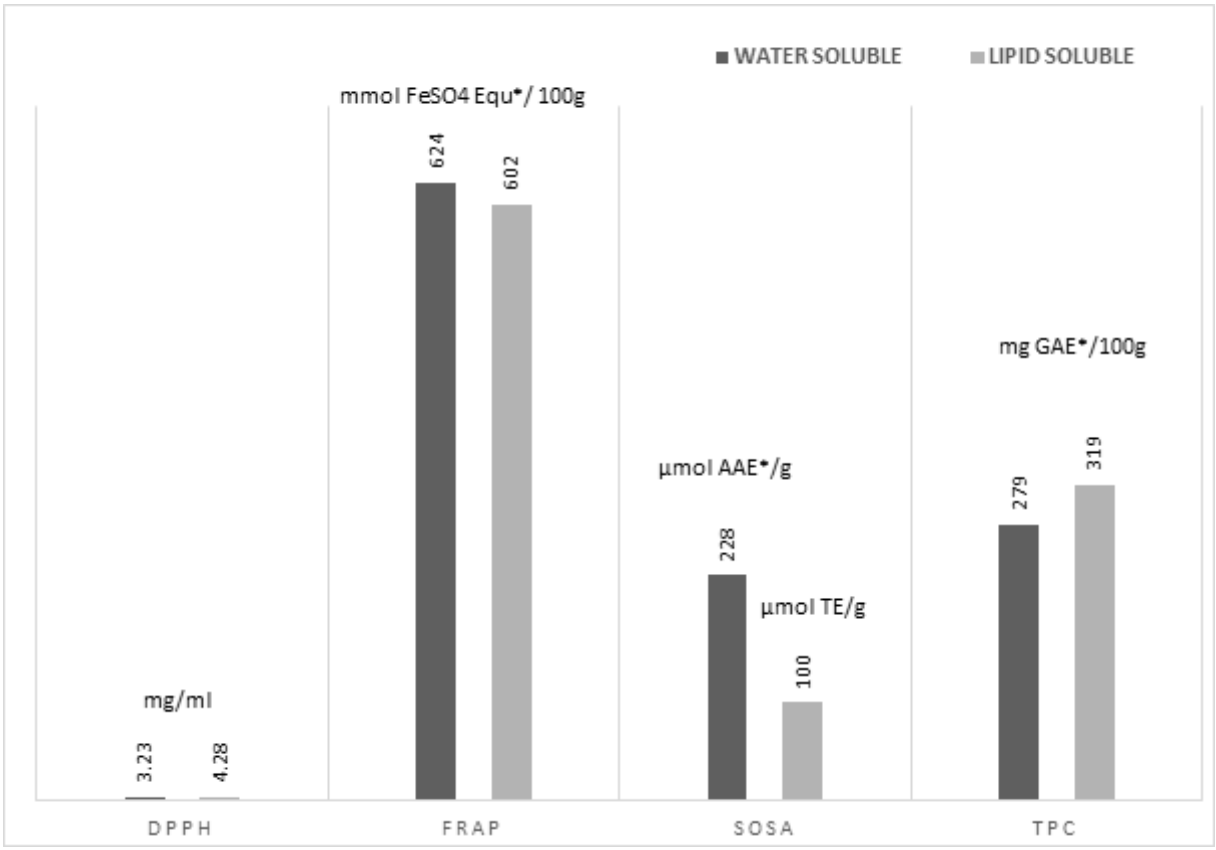
Fatty Acid		Values %
C6:0	Caproic	0.23 ± 0.001
C14:0	Myristic	30.11 ± 0.99
C16:0	Palmitic	0.53 ± 0.05
C18:0	Stearic	3.53 ± 0.09
C20:0	Arachidic	0.63 ± 0.003
C22:0	Behenic	0.47 ± 0.006
C24:0	Lignoceric	0.40 ± 0.01
C16:1	Palmitoleic	1.66 ± 0.56
C17:1	cis-10 Heptadecanoic	0.43 ± 0.001
C18:1n9c	Oleic	11.72 ± 0.23
C18:2n6c	Linoleic	47.55 ± 1.25
C18:3n6	Gamma Linolenic	0.16 ± 0.01
C18:3n3	Linolenic	2.21 ± 0.06
C20:3n6	Eicosatrienoic	0.37 ± 0.01
TSFA		35.9
TMUFA		13.81
TPUFA		50.29

Note: Each value in the table was obtained by calculating the average and standard deviation of triplicate determinations.

Antioxidant Activity and Total Polyphenol Content

Antioxidant activity and total polyphenol content of the fruit quantified is illustrated in Figure 2. IC 50 values of *Rhus semialata* fruit were 3.23 mg/ml for lipid soluble and 4.28 mg/ml for water soluble in DPPH assay. IC50 is the amount of sample extracted into 1 mL solution necessary to decrease by 50% the initial DPPH concentration. The DPPH assay measures the ability of the fruit extract to donate hydrogen to the DPPH radical resulting in bleaching of the DPPH solution. The greater the bleaching action, the higher the antioxidant activity, and this will be reflected in a lower IC50 value. The IC 50 of this fruit was comparable to the IC50 values of fruits like starfruit, sugar apple and orange for DPPH assay (Lim *et al.*, 2006). In FRAP, which measures the ability of the extract to donate electron to Fe (III), the fruit showed antioxidant activity of 624 and 602 mmol equivalent of $FeSO_4$ in 100 g of the sample for lipid soluble and water soluble respectively. The fruit exhibited 228 µmol ascorbic acid equivalent per gram of the sample for water soluble extract and 100 µmol trolox equivalent per gram of sample for lipid soluble extract in superoxide anion radicle scavenging assay (SOSA). The total polyphenol content of the fruit was 279 mg GAE in 100 g for water soluble and 319 mg GAE in 100 g of lipid soluble sample which was

Figure 2: Antioxidant Activity (DPPH, FRAP, SOSA) and Total Phenolic Content (TPC) of *Rhus semialata*



Note: Each value in the graph was obtained by calculating the average of triplicate determinations; * Equ - Equivalent, AAE - Ascorbic acid equivalent, TE - Trolox equivalent, and GAE - Gallic acid equivalent.

higher than the total polyphenol content of the other fruits reported by Lim *et al.* (2006). Many of the phenolic compounds had shown to exhibit high level of antioxidants activities (Razali *et al.*, 2008). Phenolic compounds contribute to the overall antioxidant activities in plants mainly due to their redox properties. Generally, the mechanism of phenolic compounds for anti-oxidant activity are neutralizing lipid free radicals and preventing decomposition of hydroperoxides into free radicals (Javanmardi *et al.*, 2003).

Individual Polyphenol Content

Polyphenols are secondary metabolites of plants which have antioxidant properties, present in abundance in our diet and have probable role in the prevention of various diseases associated with oxidative stress, such as cancer and cardiovascular and neurodegenerative diseases (Scalbert *et al.*, 2005). Twenty one polyphenols were quantified in *Rhus semialata,* out of which vanillic acid, sinapic acid, rutin, daidzein and luteolin were Below the Detectable Level (BDL). Gallic acid was found to be most abundant polyphenol with a content of 117 mg/100 g of the sample. The other phenolic acids found in the fruits were protocatechuic acid (1.95 mg), chlorogenic acid (0.093 mg), p-hydroxybenzoic acid (0.967 mg), caffeic acid (0.007 mg), ferulic acid (0.032 mg), p-coumaric acid (0.01 mg), o-coumaric acid (0.038 mg) and ellagic acid (6.35 mg) in 100 g of sample. Gallic acid, caffeic acid and ellagic acid were reported to be important phenolic acids found in another species of *Rhus*, i.e., *Rhus hirta* (Wu *et al.*, 2013) and *Rhus typhina* (Lai *et al.*, 2014). Among the flavones, the fruit had 0.025 mg/100 g of apigenin and 0.537 mg/100 g of luteolin-7-o-glucoside. Catechin content of the fruit was 1.64 mg/100 g. Quercetin, kaempferol and myricetin belonging to flavonols group, were observed in the fruit with content of 1.68, 0.292 and 1.45 mg/ 100 g respectively. Quercetin was also observed in both *Rhus hirta* and *Rhus typhina* (Wu *et al.*, 2013; and Lai *et al.*,

Table 5: Individual Polyphenol Content of *Rhus semialata*

Individual Polyphenol	Values mg/100 g
Gallic acid	117 ± 1.03
Protocatechuic acid	1.95 ± 0.01
Chlorogenic acid	0.093 ± 0.001
Vanillic acid	BDL*
p-hydroxybenzoic acid	0.967 ± 0.01
Caffeic acid	0.007 ± 0.0001
Sinapic acid	BDL*
Ferulic acid	0.032 ± 0.003
p-coumaric acid	0.010 ± 0.001
o-coumaric acid	0.038 ± 0.004
Ellagic acid	6.35 ± 0.056
Rutin	BDL*
Daidzein	BDL*
Apigenin	0.025 ± 0.001
Luteolin	BDL*
Luteolin-7-o-glucoside	0.537 ± 0.05
Catechin	1.64 ± 0.08
Quercetin	1.68 ± 0.06
Kaempferol	0.292 ± 0.01
Myricetin	1.45 ± 0.05
Hesperetin	19.93 ± 0.99

Note: Each value in the table was obtained by calculating the average and standard deviation of triplicate determinations; BDL - Below Detectable level.

2014). Hesperetin (19.92 mg/100 g) was the only flavonone found in the fruit and second most abundant polyphenol after gallic acid. The hesperetin content was comparable with sweet lime pulp which had 22.17 mg/100 g (Longvah *et al.*, 2017).

CONCLUSION

Overall, the data from this study shows the picture of nutrient composition, antioxidant activity and individual polyphenol content of the fruit which would help in prospecting this underutilised fruit. The present work was primarily aimed to fill up the basic limited experimental results of the fruit. Results of the experimental data do not essentially determine the superiority of the fruit. Considering the presence of both primary and secondary metabolites, *Rhus semialata* could be a potential underutilised food source in terms of nutrients and phytonutrient application. Value addition and commercialization of such wild fruit will uplift the socio-economic conditions of rural people and attract the interest of consumer.

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