Phytochemical composition, nutritional values, traditional uses of *Tetrapleura tetraptera* and *Ricinodendron heudelotii* and their pharmacological activities: an update review

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**REVIEW**

**Abstract**

The exploration of the use of natural herbs drug, especially plant parts, is a major area of focus. Medicinal plants are being increasingly used to manage a wide numerous ailment. *Tetrapleura tetraptera* and *Ricinodendron heudelotii* are known among medicinal plants having beneficial effects due to their several biological activities. The fruits and seeds of these plants are mostly used in many parts of Africa as spice for flavoring soup and making stews. This update review focused on the phytochemical characterization, traditional used, nutritional values and biological activities of these species. Both are known to possess macro- and micro-nutrients. They are rich in majority to the phytochemical’s compounds including polyphenols, flavonoids, tannins, reducing sugar, saponins and alkaloids etc. Their activities have been reported positive by several authors for both alcoholic and aqueous extractions. The plants exhibited appreciable antioxidant, anti-inflammatory and good antimicrobial activities against the test microorganisms justifying their broad-spectrum use. The hypolipidaemic, hypcholesterolaemic and hypoglycaemic properties have been proven to be efficacy especially for the plant *Tetrapleura tetraptera* and much practice remains to be done with *Ricinodendron heudelotii*. The confirmation of these biological activities is related to the high content of bioactive molecules conferring beneficial properties to plants.

**Keywords:** *Ricinodendron heudelotii, Tetrapleura tetraptera, phytochemical composition, nutritional values, traditional used, biological activities*

**INTRODUCTION**

Nowadays, plants are of increasing importance compared to synthetic drugs that were popular since many years ago. A plant becomes a medicinal plant once its ethnobotanically reported and scientifically established. It is known that a medicinal plant is any plant which contains substances that can be used for the therapeutic purpose or substances which are precursors for the synthesis (Edeoga et al., 2005). The plants contain various groups of phytochemicals as flavonoids, tannins, cardiac glycosides, saponins, steroids, terpenoids, reducing sugar, alkaloids etc. called secondary metabolites, which are biologically active. They are also known to have a high amount of essential nutrients, vitamins, minerals, fatty acid and fiber which make them suitable for use of the treatment of different diseases (Gafar and Itodo, 2011). The plants can be used for multiple purposes as preventive and curative treatment, ingredients in some recipes and also as insecticides for their pronounced aroma. *Ricinodendron heudelotii*
and Tetrapleura tetraptera, are the plants that caught our attention because they are widely consumed in Cameroon as a spice and as a diuretic for the management of obesity. These are the herbal drugs cited during an ethnobotanical survey collected via oral interviews with traditional healers of the localities of Dschang/ Cameroon (Epoh et al., 2020). In the literature, according to the traditionally used reported, many authors have studied the phytochemical aspect, nutritional value, and pharmacological activities of these 2 medicinal plants and they have shown excellent properties. The main objective of this review is to highlight some of these results including antioxidant, anti-inflammatory, antimicrobial, hypolipidemian, hypocholesterolemian and hypoglycaemic properties.

**BOTANICAL DESCRIPTION OF PLANTS**

**Ricinodendron heudelotii**

*Ricinodendron heudelotii* (Baill) is a forest tree that is native to Central and West Africa and belongs to the Euphorbiaceae family. It is a rapid growing tree reaching up to 50 m in height and an average 2.7 m in girth. The trunk is straight with short buttress. The bark is grey and his inner ranges from pink to red (Saad et al., 2019). The branches grow more or less horizontally and produce dense green matte foliage. The leaves are alternate with 3-5 leaflets, 6-30 cm long and 3-12 cm wide. Young leaves are green pale in color and mature leaves darker green having a petiole up to 20 cm with 2 lateral glands at the top. The stipules are toothed, leafy and persistent, and clasp the stem. (Oyono et al., 2014; Saad et al., 2019). The flowers are yellowish white in color, but often green. As for fruits, they are indehiscent drupe, have a spherical shape, a length of 2–5 cm, a width of 2.5–4 cm and weighing about 19 to 47 g with 2 or 3 lobes (Saad et al., 2019). It’s yellow-green in maturity, turning black and smelling akin to an overripe apple. The fruit, which contains around 2–3 seeds, has a fleshy mesocarp and a woody endocarp (François et al., 2015). These red, brown and black seeds are flat, round, approximately 1 cm in diameter and have an oily texture. In contrast, the extracted oil is light yellow, which tastes similar to groundnut oil (Figure 1) (Saad et al., 2019). *Ricinodendron heudelotii* grows in rainforest and in deep, on acidic, medium-textured, well-drained soils at 200–500 m altitude. The tree begins to bear ruit at the 8-10 years (Momeni et al., 2005).

**Tetrapleura tetraptera**

*Tetrapleura tetraptera* Taub is a species of deciduous tree belonging to the Fabaceae family, it reaches 20-25 m in height with a circumference of 1.2-3 m (Figure 2). It’s found throughout the high forest in riparian forests, in southern savannas and in African forests (Adesina et al., 2016). The bark is smooth, gray-brown, very thin; reddish, strong odor. Twigs and young foliage are almost hairless or minutely hairy. The leaves are hairy sessile with a common stem 15-30 cm long, slightly channeled on the upper surface (Adesina et al., 2016). The pinnae are 5-9 pairs, 5-10 cm long, mostly opposite but sometimes alternating; 6-12 leaflets on each side of the pinna stem, always alternating, 12-25 mm long, 6-12 mm wide, with slender stems about 2 mm long; the flowers are creamy pink in color and turn orange and are densely branched 5-20 cm long. The fruit is very persistent, hanging from the ends of the branches on the stems. It is shiny, glabrous, dark brown-

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Figure 1. (A) Tree; (B) fruits; (C) seeds; and (D) oil of *Ricinodendron heudelotii* (Saad et al., 2019)

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purple, about 5 cm in diameter, with 4 longitudinal veins almost 3 cm wide (Akintola et al., 2015). Two of the wings are woody, the other 2 filled with sweet, sugary, oily and aromatic pulp. The seeds in the pods, are small, black, hard, flat, about 8 mm long and contains oil (Ojewole and Adewunmi, 2004).

Figure 2. (A) Tree, (B) Mature dried fruits, (C) Seeds and (D) Pulp extracted from the fruit of *T. tetraperta* (N’zebo et al., 2018; Larbie et al., 2020).

**TRADITIONAL USES**

Plants or herbs are traditionally and usually consumed for numerous medicinal reasons as treatment of various diseases. Others are also used as a spice for flavouring sauce or soups. Data from the literature shows us the uses of the two interest plants namely *Ricinodendron heudelotii* and *Tetrapleura tetraptera*.

*Ricinodendron heudelotii*

Commonly known as “Njangsa” established from the Greek, it’s called “Njansang” and “Essessang” in Bamileke and Ewondo ethnicities in Cameroonian cultures, “Okwe” and “Erimado” in Igbo and Yoruba cultures in south-eastern Nigeria, “Akpi” in Cote d’Ivoire and Groundnut tree or African nut tree in English (Saad et al., 2019). Different parts of the tree are using for many purpose as following describe. The seeds of *Ricinodendron heudelotii* are widely used as a food ingredient or spice in the kitchen and oils are often extracted from these seeds (Izundu and Nnacho, 2011). The dried almonds pounded into paste or ground with other spices are more used by the population of the South-West region of Cameroon to not only set off the taste of sauces and thicken them, but also make soups and stews (Kimbu et al., 1991). Moreover, they are also used when roasting chicken, vegetables and could be good for salad dressings. (Saad et al., 2019). The seed oil has a sweet flavour, it is applicable in varnishes, soft soaps and could be serve as raw materials for the production of resins (Yirankinyuki et al., 2018). In addition, the seed oil could be beneficial for diabetics as well as against cardiovascular disease, atherosclerosis and smallpox (Matig et al., 2006; Yeboah et al., 2011; Yatindo et al., 2017). The protein-rich leaves are eaten as a cooked vegetable with dried fish and also as fodder for goats and sheep (Izundu and Nnacho, 2011). In traditional African medicine, the leaves and latex are used in rural areas of Cameroon as a purgative, to prevent abortion and applied daily to the skin to combat Varicella infection (Yakubu et al., 2019; Saad et al., 2019). Moreover, this part is used for treating abscesses, boils, fever and fungal infections and (Yatindo et al., 2017). The juice is instilled into the eye against heartworms and ophthalmia, and decoctions are used to lower fever. They are also used to treat dysentery, female infertility, oedema and stomach ache (Momeni et al., 2005). The bark of the roots and trunk is used as a decoction or lotion to treat constipation, cough, dysentery, rheumatism, rickets in children, edema, yeast infection, gonorrhea, kidney problems, hemorrhoids, ovarian cysts painful menstruation and also as a diuretic (Momeni et al., 2005; Yatindo et al., 2017). The wood is sometimes used for sculpture and to make household utensils, furniture, crates (Saad et al., 2019).

*Tetrapleura tetraptera*

In Cameroon, it is called the 4-sided fruit tree in relation to the different faces of the fruit. Also known as "Esesè", "djetk", "Sépañ" and "Sasős" in Sawa, Ewondo, Bamileke and Bassa ethnicities in Cameroon respectively; "Aridan" in western Nigeria or "Preksesse" among the Akan of Ghana and "Aidan tree" in English (Adesina et al., 2016; N’zebo et al., 2018). Its use in traditional medicine is widespread (leaves, bark, roots and grains). In West Africa, this plant serves as a medicinal product in the local folk medicine for the treatment of several ailments including gastric ulcer, rheumatism, fevers, rash, convulsion, smallpox, malaria, dysentery, inflammation, hypertension, jaundice, leprosy, diabetes, arthritis also treats coughs and hemorrhoids (Nwaichichi et al., 2013). In Cameroon, the fruits are used as a spice for flavoring soups and mix with others spices for cooking sauces, especially as « sauce jaune », « nkondré »,. In Nigeria, it’s also used for manufacturing of seasoning spices, pomades and soaps due to its pleasant aroma characteristics while in Ghana, fruits are used in soups of nursing mothers to prevent post-partum contractions, also as vitamin, and with flowers as perfumes, (Adetunji, 2007; Akintola et al., 2015). The dry fruit has a pleasant aroma that is insect-repellent in nature (Aladesanmi, 2007). An infusion of the whole fruit is usually taken by convalescents for bathing in order to be relief from feverish conditions and for constipation (Akintola et al., 2015). The stem barks mixture of *T. tetraperta* Taub. and *R. heudoletti* Bail is locally used as diuretic and for the management of obesity (Dongmo et al., 2019).

**NUTRITIONAL VALUE**
The macro and micronutrients are both the elements playing an important role in the maintenance of the body’s well-being and metabolism (Iронди et al., 2013). While proteins are involved in the synthesis of enzymes, hormones and antibodies for the good growth, maintenance of our cells and tissues, carbohydrates and lipids constitute the energy fuel and act like minerals in physiological, metabolic and other biological activities in the organism. The nutritional aspect of many plants has been demonstrated including *Ricinodendron heudelotii* and *Tetrapleura tetraptera*.

**Ricinodendron heudelotii**

The study made by Ezekwe et al., (2014) on nutritive composition of omega-3 fatty acids-rich of *R. heudelotii* and its potential for nutrition showed that the compositional analyses of seed had 31.4% of crude protein and 44.7% of lipid (oleic and ecosapentaenoic acid) with a highest energy values of 2000 kJ/480 kcal. Furthermore, those studies undertaken by Enel Obong et al., 2018 revealed high content of protein (30.6%), fat (24.5%), ash (3.6%) and fiber 9.5%. This plant constitutes a source of many nutrients like omega-3 fatty acids, essential amino acid, and vitamin A and E. According to the work of Kinge et al., (2019), The proximate composition of Djansang seeds revealed that the seeds are approximately rich in proteins (~22%), lipid (~46%), carbohydrates (~25%). The main lipid is polyunsaturated fatty acids (~79%) among which the most represented essential fatty acid is linoleic acid (~28.3%). They also contain several minerals elements as calcium values ranged from 415 to 660 mg/100 g; 220 to 715 mg/100 g for potassium, 130 to 690 mg/100 g for phosphorus, 230 to 690 mg/100 g for magnesium, 210 to 323 mg/100 g for sodium and 5.85 to 19.5 mg/100 g for manganese (Besong et al., 2011). In addition, the work of Saki and et al., (2005) confirmed the presence of high content of dry material, protein, lipid, sugar, starch, cellulose, calcium, magnesium, phosphor, potassium, sodium, chlorine with 92 %, 24 %, 47 %, 0.084 %, 0.42 %, 2.4 %, 0.33 %, 0.2 %, 1.7 %, 0.8 %, 0.033 % respectively. Likewise, Uzoekwe and Hamilton, (2016) as reported that, the leaf and bark of the extract contain respectively: moisture content (25.80% and 10%), protein (17.47% and 3.73%), crude fat (1.80% and 2.00%) ash (11.00% and 10.95%), crude fiber (41.00% and 20.50%) carbohydrate (2.93% and 52.82%) while the mineral analysis showed following values, calcium – 2640.00 mg/kg and 1772 mg/kg, magnesium – 2383 mg/kg and 1605 mg/kg, iron – 25.00 mg/kg and 6.6 mg/kg, zinc – 29.30 mg/kg and 4.4 mg/kg, copper – 14.60 mg/kg and 6 mg/kg and phosphorus – 1012 mg/kg and 305 mg/kg for Manganese.

**Tetrapleura tetraptera**

The nutritional importance of *T. tetraptera* fruit was evaluated and the proximate composition (%) values of macro-nutrients were protein (5.61-6.69), moisture (5.06-8.22), fat (11.19-24.71), carbohydrate (58.48-63.86), ash (2.65-4.02) and fiber (3.14-4.11). In the same way, the composition (mg/100g) values of micro-nutrients shows different minerals as Calcium values ranged from 690 mg/100 g for magnesium, 210 to 715 mg/100 g for potassium, 130 to 690 mg/100 g for phosphorus, 230 to 690 mg/100 g for magnesium, 210 to 323 mg/100 g for sodium and 5.85 to 19.5 mg/100 g for manganese (Besong et al., 2011). In addition, the work of Saki and et al., (2005) confirmed the presence of high content of dry material, protein, lipid, sugar, starch, cellulose, calcium, magnesium, phosphor, potassium, sodium, chlorine with 92 %, 24 %, 47 %, 0.084 %, 0.42 %, 2.4 %, 0.33 %, 0.2 %, 1.7 %, 0.8 %, 0.033 % respectively. Likewise, Uzoekwe and Hamilton, (2016) as reported that, the leaf and bark of the extract contain respectively: moisture content (25.80% and 10%), protein (17.47% and 3.73%), crude fat (1.80% and 2.00%) ash (11.00% and 10.95%), crude fiber (41.00% and 20.50%) carbohydrate (2.93% and 52.82%) while the mineral analysis showed following values, calcium – 2640.00 mg/kg and 1772 mg/kg, magnesium – 2383 mg/kg and 1605 mg/kg, iron – 25.00 mg/kg and 6.6 mg/kg, zinc – 29.30 mg/kg and 4.4 mg/kg, copper – 14.60 mg/kg and 6 mg/kg and phosphorus – 1012 mg/kg and 305 mg/kg for Manganese.

**PHYTOCHEMICAL COMPOSITION**

Many studies have been done on the identification of qualitative and quantitative phytochemicals compositions of the different part of plants including leaves, fruits, seeds and bark. The qualitative tests are generally carried out through the colorimetric methods as shown in Table 1.

<table>
<thead>
<tr>
<th>Phytochemical compounds</th>
<th>Test</th>
<th>Observations (positive results)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkaloids</td>
<td>Mayer's reagent</td>
<td>Yellowish white precipitate</td>
</tr>
<tr>
<td></td>
<td>Draggendorf’s reagent</td>
<td>Orange-red precipitate</td>
</tr>
<tr>
<td>Tannins</td>
<td>Ferric chloride</td>
<td>Blue-black coloring</td>
</tr>
<tr>
<td>Flavonoids</td>
<td>Shinoda test with magnesium powder</td>
<td>Orange coloring</td>
</tr>
<tr>
<td>Anthocyanins</td>
<td>50% hydrochloric acid and ammonia</td>
<td>Purlphl red color</td>
</tr>
</tbody>
</table>

Table 1: Screening test and observations of phytochemical compounds (Victorin et al., 2018)
The scientific names of the plants, the corresponding families, the parts used, the different types of solvents as well as the major compounds elucidated as shown in the table 2.

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Part of plants</th>
<th>Extraction type</th>
<th>Major phytochemical compounds</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ricinodendron heudelotii</strong> Baill Euphorbiaceae family</td>
<td>Leaves</td>
<td>Ethanol, Hexane, Ethylacetate, Butanol, Aqueous and Methanol / dichloromethane</td>
<td>Tannins, flavonoids, alkaloids, cardiac glycosides, saponins, coumarins, steroids, sterols, anthocyanins, phenol and terpenoids</td>
<td>[Momeni et al., 2010; Uzoekwe and Hamilton, 2016; Yakubu et al., 2018]</td>
</tr>
<tr>
<td></td>
<td>Barks</td>
<td>Ethanol, Methanol</td>
<td>Tannins, steroids, terpenoids, flavonoids, cardiac glycosides, saponins Alkaloids, polyphenols, phenols</td>
<td>[Oyono et al., 2014; Uzoekwe and Hamilton, 2016]</td>
</tr>
<tr>
<td></td>
<td>Seeds and oil</td>
<td>Aqueous, Ethanol, N-hexane and Ethyl acetate</td>
<td>Resins, alkaloids, flavonoids, tannins, saponins, antraquinones, cardia glycosides, carotenoids, steroids, phenols and terpenoids</td>
<td>[Odinga et al., 2016; Ogbuagu et al., 2019]</td>
</tr>
<tr>
<td><strong>Tetrapleura tetraptera</strong> Taub Fabaceae family</td>
<td>Fruit peel</td>
<td>Ethanol</td>
<td>Alkaloids, flavonoids, tannins, saponins, cardia glycosides, reducing sugar, steroids, phenols and terpenoids</td>
<td>[Erukainure et al., 2017]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Methanol</td>
<td>Saponins, Alkaloids, flavonoids, tannins, glycosides, steroids, phenols, carbohydrates and terpenoids</td>
<td>[Aikins et al., 2021]</td>
</tr>
<tr>
<td></td>
<td>Fruit</td>
<td>Aqueous, ethanol, hydroethanolic and methanolic</td>
<td>flavonoids, tannins, saponins, reducing sugar, triterpenoids, polyphenols, anthocyans, antraquinones, glycosides, steroids and coumarins</td>
<td>[Mbieleu et al., 2016; Larbie et al., 2020; Obeng et al., 2021]</td>
</tr>
<tr>
<td></td>
<td>Stem bark</td>
<td>Aqueous, ethanol, hydroethanolic and methanolic</td>
<td>Flavonoids, tannins, coumarins, saponins, reducing sugar, steroids and terpenoids, alkaloids, polyphenols, anthocyans, antraquinones, glycosides</td>
<td>[Mbieleu et al., 2016; Larbie et al., 2020; Obeng et al., 2021]</td>
</tr>
<tr>
<td></td>
<td>Leaves</td>
<td>Aqueous, hydroethanolic, methanolic, ethyl acetate, dichloromethane and n-hexane</td>
<td>Tannins, alkaloids, reducing sugar, coumarins, flavonoids and terpenoids, saponins, sterols and phenols</td>
<td>[Enema et al., 2019; Larbie et al., 2020]</td>
</tr>
</tbody>
</table>

By spectrometry it has been established from the ethyl acetate fraction of *R. heudelotii* the presence of 9 compounds among which, one belonging to tannins group called corilagin (Table 3) (Yakubu et al., 2019). Catechin and gallic acid derivatives were found in bark, while fatty acid in seeds (Table 3) (Stefania et al., 2019). The study of Mawa et al, (2019) on the evaluation of the antioxidant activity of the aqueous and methanolic extracts from barks of *T. tetraptera* showed that the total phenolic contents of the aqueous extract were lower than the methanolic extract with 78.66 ± 0.12 mg GAE/g and respectively 464.66 ± 0.22 mg GAE/g of extract (GAE = Gallic acid equivalent). As for total flavonoid, the quantity determined for the aqueous extract (E. Aec) is 17.33 ± 0.97 mg QE/g when the methanolic extract (E. Mec) gave 147.33 ± 0.45 mg QE/g of extract. From fruits, the total polyphenols contents, flavonoids and flavonols of hydroethanolic extract

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(70/30) were 273.48 ± 1.82, 5.2549 ± 0.04 and respectively 1.615 ±0.07 mg SE/g dried extract (Saague et al., 2019). As for Akin-idowu et al., (2011) the quantitive phytochemicals (mg/100 g) based on weighted dry fruit were total polyphenol (38.05 to 2907.15); flavonoid (10.30 to 410.75); saponin (60.80 to 953.40); tannin (135.50 to 1097.50); and phytate (1021.00 to 5170.00). However, it is reported that the seeds of this plant showed the presence of phenols (0.34 %), flavonoids (0.91 %), alkaloids (0.52 %), tannins (0.23 %) and saponins (0.51 %) (Igwe and Akabuike, 2016). Numerous structures of the compounds found in *R. heudelotii* and *T. tetraptera* were elucidated by many authors and presented in Table 3.

**Table 3.** Some metabolites isolated from *Ricinodendron heudelotii* and *Tetrapleura tetraptera*

<table>
<thead>
<tr>
<th>Structures</th>
<th>Systematic names</th>
<th>Classes of metabolites</th>
<th>Pharmacological activities</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ricinodendron heudelotii</strong></td>
<td>beta-1-O-galloyl-3,6-(R) hexahydroxydiphenoyl-d-glucose (Corilagin = C27H22O18)</td>
<td>Tannin</td>
<td>Antioxidant, anti-inflammatory</td>
<td>[Yakubu et al., 2019]</td>
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<tr>
<td></td>
<td>2-(3,4 dihydroxyphenyl) chromane-3,5,7-trio Catechin= C15H14O6</td>
<td>Flavonoids</td>
<td>Antioxidant, anti-inflammatory, antibacterial</td>
<td>[Sut et al., 2019]</td>
</tr>
<tr>
<td></td>
<td>3,4,5-trihydroxybenzoic acid) gallic acid= C7H6O3</td>
<td>Phenolic acid</td>
<td>Antimicrobial, antioxidant, antimicrobial, anti-inflammatory</td>
<td>[Sut et al., 2019]</td>
</tr>
<tr>
<td><strong>Tetrapleura tetraptera</strong></td>
<td>7-Hydroxy-6-methoxy-2H-1-benzopyran-2-one</td>
<td>Phenolic compound</td>
<td>Diuretic, antidiabetic, Antioxidant, anti-inflammatory</td>
<td>[Manaharan et al., 2012; Kostova et al., 2011; Husain et al., 2016]</td>
</tr>
<tr>
<td></td>
<td>Acide phenylpropanoide ferulic acide caffeic acide p-coumaroic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2', 4, 4'-trihydroxychalcone-Isoliquiritigenin</td>
<td>Flavonoids</td>
<td>Antioxidant, anti-inflammatory, hypoglycaemian, hypolipidaemian</td>
<td>[Aderibigbe et al., 2010]</td>
</tr>
<tr>
<td></td>
<td>2', 3, 4, 4'-tetrahydroxychalcone-Buteine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4', 5, 7-trihydroxyflavanone-Naringenin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Acide 3-O-[β-Dglucopyranosyl-2'-acetamido-2'-deoxy]-oleanolic</td>
<td>Saponins</td>
<td>diuretic, hypoglycaemian, hypolipidaemian</td>
<td>[Aderibigbe et al., 2010; Kuate et al., 2015; Hussein et al., 2016]</td>
</tr>
<tr>
<td></td>
<td>Acide 3-[(O-β-Dglucopyranosyl-(1→6)-β-D-glucopyranosyl]-oxy]-27-hydroxyolean-12-en-28-oic</td>
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<td></td>
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</tbody>
</table>

**BIOLOGICAL ACTIVITIES**
Herbs are widely used in traditional medicine for the treatment of numerous ailments. As they are growing interest, the literature review was carried out to list the various biological activities that have already been scientifically done. Studies have reported an antimicrobial, antioxidant, anti-inflammatory, hypolipidemic and hypocholesterolemic properties in the plants of interest.

**Antioxidant activity**

**Ricinodendron heudelotii**

Plants are usually known for their richness in natural antioxidants having beneficial effect in human health. Antioxidant activity is generally attributed to some secondary metabolites of the class of flavonoids, phenols and tanins. Likewise, certain nutrients as vitamin A, C, E and the trace elements such as copper, manganese and magnesium also act as antioxidants (Li et al., 2018; Yakubu et al., 2019). According to Ene-Obong et al., 2018, aqueous extract of *R. heudelotii* of the seeds contains highest flavonoids content and low total phenol and vitamin C content at 3.64 mg/GAE/g and respectively 2.03 mg AAE/g. These authors found that, the extract had the least FRAP (1.77 mg AAE/L) and DPPH scavenging ability (56.1%) with EC50 of 12.81 lg/mL compared to other spices studies. Similarly, the leaf methanol/dichloromethane (1+1) extract showed weak free radical scavenging activities as compared to Trolox (939.19 µg/mL) used as standard (Momeni et al., 2010). Unlike, Oyono et al., (2014) demonstrated that the evaluation of trapping of DPPH radical revealed a high antiradical activity of the methanolic extract from barks of *R. heudelotii* with a SC50 of 7.21 mg/mL. Furthermore, the methanol stem bark extract exhibited highest total antioxidant capacity (3.86 mmol trolox equivalent (TE)/g), radical scavenging (487.30 and 1043.42 mg TE/g, for DPPH and ABTS), and reducing power (752.85 and 1230.96 mg TE/g, for FRAP and CUPRAC), while high metal chelating activity was measured for especially the seed water extracts (Stefania et al., 2019). On the other hand, the study of Yakubu et al., (2019) made on the anti-inflammatory and antioxidant activities of fractions and compound from *R. heudelotii* was reported that, butanol, ethyl acetate as well as Corilagin, an amorphous tannin, showed scavenging effect against ABTS and DPPH radicals which vary in a dose dependent manner. Likewise, Corilagin also exhibited the highest antioxidant potential with IC50 value of 0.003 mg/Ml comparable to vitamin C 0.001 mg/mL used as standard. As for in vivo aspect, Odinga and Nwoakoze, 2020 showed that, aqueous seed extract of *R. heudelotii* has the potency to reduce glucose level and act as antioxidants against oxidative stress by significantly decreasing the blood glucose concentration, malondialdehyde (MDA) and increasing catalase activity.

**Tetrapleura tetraptera**

As shown by Famobuwa et al. (2016), the reductive ability of the stem bark and fruit ethanol extract ranged from 0.393 to 1.641 and from 0.342 to 1.325 mg ascorbic acid equivalent per mL of extract respectively. The percentage DPPH radical inhibition ability of the stem bark ranged from 28.74% to 85.26% while the fruit ranged from - 10.56% to 66.01% but at the lower concentration (25 mg/mL) the fruit extract exhibited a pro-oxidant activity. Furthermore, the study of Erukinairue et al. (2017) was reported that, the ethanolic extract of fruit peels revealed a high antioxidant activity as indicated DPPH radical scavenging ability with EC50 equal to 69.32 mg/mL as compared to gallic acid (EC50 = 46.51 mg/mL) at highest concentration of 100 µg/mL. Likewise, Mawa et al., (2019) showed that the methanolic extract barks exhibited a greater antioxidant property (DPPH) with IC50 = 02.57 ± 0.16 mg/mL than aqueous extract (IC50 = 07.50 ± 0.60 mg/mL) both compared to vitamin C (01,25 ± 0.02). As for fruits, hydroethanolic extract revealed that the concentration of ferric reducing the antioxidant power was 30.46 ± 0.26 mg eq Vit C/g dried extract and this extract showed scavenging effect against ABTS, DPPH, OH and NO radicals with IC50 equals to 137.67±2.08, 28.16±3.17, 69.5±0.05 and 111.67±1.15 µg/mL, respectively as compared to their vitamin C control (Saague et al., 2019). However, several studies revealed that the hydroethanolic and methanolic extracts of leaves and stem bark had the highest radical scavenging activities (DPPH) as compared to gallic acid as standard at a percent inhibition of 94.15%. Similar, Adusei et al. (2019) shown that aqueous and ethanolic extracts of pulp, seeds and whole fruit exhibited much antioxidant activity especially in pulp as compared to others.

**Anti-inflammatory activity**

It is known that plants containing phenolic compounds, flavonoids and tanins possess antioxidant and anti-inflammatory properties (Yakubu et al., 2018).

**Ricinodendron heudelotii**

The study of Yakubu et al. (2019) going on the anti-inflammatory and antioxidant activities of different fractions and isolated compounds from *R. heudelotii* leaves has reported that, the butanol and ethylacetate fractions exhibited significant (p < 0.05) oxide nitric (NO) inhibition of 60 and 69% respectively after treatment of RAW 264.7 macrophages with lipopolysaccharides. It has also been shown that Corilagin from the tannin group lower pro-inflammatory cytokines and mediators such as iNOS and TNF-a and reduced the effect of N9-murine cells injury induced by tert-butyl hydroperoxide (Zhao et al., 2008; Chen and Chen, 2011; Owolabi et al., 2018).

**Tetrapleura tetraptera**
Ojewole and Adewunmi (2004) investigated on the anti-inflammatory and hypoglycemic effects of *T. tetraptera* fruit aqueous extract in rats. The results suggested that the extract produced dose-related, significant reductions (P < 0.05–0.001) of the fresh egg albumin-induced acute inflammation of the rat hind paw edema. Moreover, Gloria et al. (2018) reported that methanolic extract of *T. tetraptera* leaf and its fractions possess varying anti-inflammatory activity by stabilizing red blood cells membrane until 1000 µg/mL and the aqueous fraction was active at inhibiting the heat-induced albumin denaturation with a maximum inhibition of 63.91% at 200µg/mL. As shown by Kuate et al. (2015), the hydroethanolic extract demonstrated an anti-inflammation effect via down regulation of tumor necrosis factor-alpha (TNF-α), interleukin-6 (IL-6), C-reactive protein (CRP), leptin and an increase in adiponectin on metabolic syndrome induced rat. Futhermore, Onda et al. (2017) revealed that a carrageenan/Kaolin-induced acute monoarthritis in rat’s paw produced a significant (p < 0.05) time and dose-dependent decrease in joint diameter, until at dose 400 mg/kg. The extract also produced maximal effect in the 5th hour in reducing knee swelling by 1.54 ± 0.27, 0.67 ± 0.14 and 0.35 ± 0.13 (inhibition by 46.0, 76.5, and 87.7%) respectively when compared to arthritic control (2.85 ± 0.09). According to Igwe and Akabuike, (2016) the hydroethanolic leaves extract showed potent free radical scavenging activity (DPPH) (6.72 – 22.8%) using ascorbic acid as a standard (12.10 - 42.00 %).

**Antimicrobial activity**

*Ricinodendron heudelotii*

The work of Fankam et al. (2017) on antibacterial and antibiotic resistance modulatory activities of leaves and bark extracts of *R. heudelotii* (Euphorbiaceae) against multidrug-resistant Gram-negative bacteria have shown that methanolic extract of leaves could be a source of natural antibacterial products as well as for antibiotic resistance modulators. Moreover, the study of Oyono et al., (2014) has reported that, crude bark methanolic extract was active on 8 of 12 strains tested, with MIC ranging from 188 to 750 µg/ml and MBC from 375 to 1500 µg/ml, having diameters of inhibition zones from 12 to 19.67 mm. Similarly, the ethanolic leaves extract revealed the inhibition zone and minimum inhibitory concentration (MIC) ranging from 18 to 36 mm and 31.25 to 62.5 mg/mL, respectively against seven microorganisms: *Pseudomonas aeruginosa*, *Shigella sp.*, *Escherichia coli* (Gram-negatives), *Staphylococcus aureus*, *Bacillus sp.*, *Micrococcus sp.*, *Streptococcus faecalis* (Yakubu et al., 2018). This ethanolic leaf extract as well as the work of Oyono et al., (2014) on the methanolic bark extract showed no inhibition against following microorganisms: *Klebsiella pneumoniae*, *Candida albicans*, and *Salmonella* sp. The study of Momeni et al., (2005) has shown that the n-hexane extract posseses a high inhibition activity against *Streptococcus faecalis*.

**Tetrapleura tetraptera**

As reported by Kwetch et al. (2016), aqueous extracts from the stem bark did not play any antibacterial potential, while aqueous extracts from the fruits inhibited all six Gram-positive and two Gram-negative multidrug-resistant tested. Igwe and Akabuike, (2016) showed that the seed extract exhibited significant antimicrobial activity (7.00 – 20.00 mm) against all test microorganism and the zones of inhibition was compared with that of ciprofloxacin as standard (15.00 – 28.00 mm). Furthermore, the study of Achi, (2010) has investigated the *T. tetraptera* pod extracts against four different types of bacterial strains: *Staphylococcus aureus* ATCC 12600, *Bacillus subtilis* (ATCC6051), *Pseudomonas aeruginosa*, (ATCC10145) and *Escherichia coli* (ATCC11775). The authors found that, the activity was particularly high against *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Escherichia coli* among all test microorganism. The study made by Larbie et al. (2020), reported that among tested microorganism as *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Escherichia coli*, *Candida albicans* and *Proteus mirabilis*, only methanolic and hydroethanolic extract of leaves and stem bark had activity ranging from a minimum inhibition of 0.97 mm for 100 mg/mL hydroethanolic leaves extract to 1.63 mm for 300 mg/mL methanolic extract of stem bark as compared to Chloramphenicol with a maximum 2.6 mm at 30 µg/mL.

**Hypolipidaemian, hypcholesterolaemian and hypoglycaemic properties**

*Ricinodendron heudelotii*

The kernels of *R. heudelotii* are traditionally used in Cameroon as spice in many dishes while stem bark is used for its diuretic effect (Epoh et al., 2020; Yatindo et al., 2017). The study of Leudeu et al. (2009) has reported that oils would alter the in vivo lipid profiles since they reduced cholesterol and triglyceride levels in rats compared with the control group fed the standard diet. It has also had hypcholesterolemic properties.

**Tetrapleura tetraptera**

As reported by Kuate et al. (2015), the hydroethanolic extract of *T. tetraptera* fruit exhibited hypolipidemic and alleviated obesity and type-2 diabetes induced hyperinsulinemia in rats by reducing weight gain, fasting blood glucose and lowered insulin level in a dose-dependent manner respectively. The extract also exhibited reduction of the serum level of triglycerides, total cholesterol, free fatty acids and increase of the HDL-cholesterol at the dose of 200 mg/kg in metabolic syndrome induced rats. In addition, studies made by Atawodi et al. (2014) showed that the methanolic extract of *T. tetraptera* leaves will have the ability to treat diabetes and its complications, reduce oxidative stress and have lipid-lowering properties. Aqueous extract of *T. tetraptera* stem bark causes a significant decrease in serum C-Total, glucose, triglycerides and C-LDL levels while increasing serum C-HDL levels observed in hypertensive rats, with a high salt and sugar content in the diet (Bella et al., 2012). Likewise, Ojewole and Adewunmi, (2004) had demonstrated that aqueous extract of *T.
tetraperta fruit shows hypoglycemic properties by produced dose-dependent, significant reductions (P <0.05–0.001) in the blood glucose concentrations of both normal fasted and diabetic fasted rats at highest dose at 800 mg/kg p.o. According to Sarah and Bosede, (2010), the methanolic extract of T. tetraperta exerts a hypolipidemic effect, reducing body weight and increasing the body’s antioxidant (superoxide dismutase, SOD and catalase, CAT) defense system in hypercholesterolemic rats.

**DISCUSSION**

*Ricinodendron heudelotii* and *Tetrapleura tetraptera* are two native trees or food plants from Africa where fruit or seeds are widely used in traditional kitchen for making sauces and stews and for flavoring soups. According to the literature data, the leaves, stem bark, fruit, seeds and even oils are frequently used for the treatment of various diseases and sicknesses. Traditionally, these plants are commonly used to treat stomach ache, smallpox, dysentery, rheumatism, fevers, constipation, cough, hemorrhoids and both act as diuretics (Momenu et al., 2005; Nwaichi et al., 2013 and Yatindo et al., 2017). *R. heudelotii*, as well as *T. tetraperta* contain essential nutrients for the diet, including proteins and lipids, helping in increasing foods with significant energy value. Many studies have revealed the presence of macro-nutrients in both plants. Although, *R. heudelotii* spice showed the highest energy value (2000 kJ / 480 kcal), a high protein and lipid content ranging between 22% - 31.4% and 24.5% - 46% respectively, then *T. tetraperta* spice with 1583 kJ / 379 kcal, protein (5.61- 10.5%) and fat (11.19-24.71%) (Ezekwe et al., 2014; Akintola et al., 2015; Ené-Obong et al., 2018 and Kinge et al., 2019). As shown by Ezekwe and Besong (2014), *R. heudelotii* contains high levels of polyunsaturated fatty acids (PUFA), rich with substantial amounts of omega-3 fatty acids, especially eicosapentaenoic acid (EPA) approximately 73% and around 18% of them were found to be oleic acid comparable to those of olive fruit and soja seed. In general, mono and polyunsaturated (EPA) fats of plant origin are recommended in the diet and also in baby cereals and for making cakes due to their richness in unsaturated fatty acids. The eicosapentaenoic acid (EPA) and docohexaenoic acid are important for proper fetal development, including neuronal, retinal and immune function and contributing to the maintenance of normal cholesterol levels, thus helping to prevent cardiovascular illnesses (Ené-Obong et al., 2018). This information was in accordance with those obtained by Akin-Idowu et al. (2011). The relatively high ash content indicates the presence of mineral constituents in the spices.

Calcium, magnesium, manganese are essential minerals involved in the formation of bones and teeth, while the iron, zinc and copper perform several important functions in the human body as the formation of hemoglobin, growth and sexual maturation and many others roles (Uzoekwe and Hamilton, 2016). Many authors shown that vitamins A, E, C and also various minerals elements (%) were detected in both plants including calcium, potassium, magnesium, manganese, sodium, iron, iodine zinc, copper etc, suggesting the exploitation in tackling micronutrient deficiency has given their importance in heart and bone health as explained by Uzoekwe and Hamilton, (2016) and Ené-Obong et al. (2018). The effectiveness of both plants would be probably due to the presence of various secondary metabolites suggesting their therapeutic use. The main phytochemicals composition found in these plants were tannins, steroids, terpenoids, flavonoids, cardiac glycosides, saponins, alkaloids and polyphenols. Several compounds have been elucidated namely Corilagin (tannin), Catechin (flavonoid), gallic acid (phenolic acid) from *R. heudelotii* and Naringenin (flavonoid), Caffeic acid (phenolic compound) from *T. tetraperta* (Aderibigbe et al., 2010; Husain et al., 2016; Yakubu et al., 2019; Stefania et al., 2019). According to Ené-Obong et al. (2018), the total phenol, flavonoid, and vitamin C are known to be a good natural antioxidant agent having beneficial effect in human health. Since they have been found in our plants of interest, this might justify their free radical scavenging abilities. The same author has shown that, aqueous extract of *R. heudelotii* seeds contains the highest flavonoids content and low total phenol and vitamin C, this might explain the least FRAP and DPPH scavenging abilities. As suggested by Larbie et al. (2020), the capacity of flavonoids to act as a powerful antioxidant and free radical scavenger would depend on the hydroxyl groups position and other features in the chemical structure. The low antioxidant ability would also result from the insufficient amount of polyphenols and vitamin C to act positively. Organic extracts exhibited highest total antioxidant capacity, expressing the strong extraction of phenolic compounds and other elements responsible for activity previously mentioned. The high activity of these organic extracts could be due to the presence of isolated compound namely Corilagin from tannin group. As reported by Jayant et al. (2008) the increased antioxidant activity was linked to the reactivity of hydroxyl group, so its increase also raised up the level of activity. The work carried out by Odinga and Nwaokezi, 2020 shown that the in vivo administration of this aqueous extract induces an antioxidant effect against oxidative stress by reducing malondialdehyde (MDA) and increasing catalase, which are two endogenous antioxidant enzymes. This activity was justified by the potentiating action of the immune system through several mechanisms. From the previous studies made by some authors, apart from the ethanol extract of *T. tetraperta* at a concentration of 25 mg / mL, which showed a pro-oxidant effect, all other extracts were found to be very active. The observed pro-oxidant activity could be explained by the excessive production of hydrogen peroxide. According to some authors, phenols, tannins and saponins can act as antioxidants throughout their ability of scavenging radicals and of chelating metal ions such as Fe (II) by restricting the accessibility of this ion in participation in Fenton reaction contributing to retard oxidation (Aleksandra, 2007; Larbie et al., 2020). However, the phenols can also exert pro-oxidant effects by auto-oxidation, leading to the formation of semiquinone and superoxide (O2.-) radicals which will generate hydrogen peroxide (H2O2), able for reducing the antioxidant capacity of phenolic compounds. Secondary metabolites including tannins, flavonoids and triterpenoids are known to have anti-inflammatory and antimicrobial effect as shown by several investigators (Ojewole and Adebunmi, 2004; Igwe and Akabuike, 2016 ; Obguagu et al., 2019). It is also known that, Corilagin has been shown to lower pro-inflammatory cytokines and mediators such as iNOS and TNF-α by blocking the
NF-kb pathway in macrophage cell lines stimulated by lipopolysaccharide (LPS) (Yakubu, 2019). Since these compounds were found in the plant of interest, it could explain the obtained activities. Both plants exhibited appreciable anti-inflammatory and antibacterial activities against the test microorganisms probably due to the presence of various bioactive compounds like polyphenols, tannins, flavonoids, alkaloids, steroids and saponins as demonstrated by Oyono et al. (2014). As for hypolipidemic and hypocholesterolemic properties, the reported scientific data showed the ability of T. tetraptera to decrease seric levels of triglycerides, total cholesterol, LDL cholesterol and increase in seric level of HDL. The reduction in TAG and cholesterol result, firstly from the inhibition of fatty acid synthase and acetyl CoA carboxylase, enzymes that are involved in lipogenesis and therefore inhibit the accumulation of fats in adipose tissue, or secondly from the inhibition of the activity of HMG CoA reductase which plays a very important role in the synthesis of cholesterol (Dongmo et al., 2019). To our knowledge and apart the oils from R. heudelotti, no studies have been carried out on the use of its other parts (like leaves and barks) for the control of metabolic syndromes. So, many studies need to be done on this aspect.

CONCLUSIONS

Tetrapleura tetraptera and Ricinodendron heudelotii are frequently used as spices and appear that they are very rich in phytochemicals and nutrient elements. Their richness in essential nutrients make them a potential source to fight against malnutrition. They have proven antibacterial, antioxidant, anti-inflammatory, hypolipidemic, hypocholesterolemic and hypoglycemic activities. Although there are an increasing number of scientific literature to support the use of these plants as medicines and as food, there is a need to continuously investigate not only Ricinodendron heudelotii but also its association with Tetrapleura tetraptera in the control of metabolic syndromes as mentioned by traditional healers.

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Conflicts of Interest

The authors declare no conflict of interest.

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