Innovare Academic Sciences

International Journal of Pharmacy and Pharmaceutical Sciences

ISSN- 0975-1491 Vol 7, Issue 3, 2015

Original Article

ANTI-INFLAMMATORY ACTIVITIES OF FRUIT AND LEAVES EXTRACT OF *LANNEA MICROCARPA* ENGLAND K. KRAUS (ANACARDIACEAE)

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Received: 10 Dec 2014 Revised and Accepted: 01 Jan 2015

ABSTRACT

Objective: To investigate the anti-inflammatory activity as well as carotenoid content of crude hydro-acetonic extract of fruit and leaves of *Lannea microcarpa* (*L. microcarpa*) and to elucidate the possible anti-inflammatory mechanism by enzymatic and non-enzymatic methods.

Methods: Anti-inflammatory activity was determined by using carrageenan induced paw edema in mice; the anti-inflammatory mechanism may have been assessed using the inhibitory effect of the extracts, on the lipoxygenase, xanthine oxidase, lipid peroxidation and the reduction of Fe^{3+}.

Results: At the doses of 100mg/kg, 200mg/kg, 400mg/kg, the extracts of both fruit and leaves reduced the carrageenan-induced paw edema while the dose of 200 mg/kg has produced a maximum percentage of inhibition of mice paw edema both for fruit (78.44%) and leaves (58.02%) at the fifth hour compared to control. Significant lipoxigenase and xanthine oxidase inhibitory effect was obtained with both fruit and leaves extract ethyl acetate fraction. Ethyl acetate fraction from both extracts inhibited lipid peroxidation. The fruit and leaves extract ethyl acetate fraction also inhibited lipid peroxidation with 32.85% and 78.07% respectively. Crude acetonic extract of leaves of *Lannea microcarpa* has shown a significantly reducing power of Fe^{3+} by 9.46±0.26 and high carotenoids content compared to those of fruit extract.

Conclusion: The results obtained from the present study suggest that *Lannea microcarpa* fruit and leaves extract possess significant anti-inflammatory and antioxidant capacities (mg AAE/100 mg). Therefore, they could be useful for food and pharmaceutics industries.

Keywords: *Lannea microcarpa*, Anti-inflammatory, Antioxidant, Carotenoids, Fruit, Leaves.

INTRODUCTION

Increasing numbers of reports have confirmed that consumption of fresh fruits and vegetables may increase protection against some chronic diseases caused by oxidative stress such as cardiovascular disorders and cancer [1, 2]. This is mainly attributed to their anti-inflammatory and anti-oxidant constituents such as vitamin C, carotenoids, phenolics, flavonoids, tannins and anthocyanidins which are known to possess the ability to scavenge free radicals and inhibit lipid peroxidation [3]. While inflammation occurring as a consequence of oxidative stress is not the only biological manifestation of excess reactive oxygen species/reactive nitric species (ROS/RNS) [4], inflammatory diseases resulting from oxidative stress are the causes of many human diseases [5]. Non-steroidal anti-inflammatory drugs (NSAIDs) are prescribed worldwide for the management of pain, inflammation and fever, as well as cardiovascular protection. However, due to the high gastric lesion risks of NSAIDs [6], there is much hope for finding anti-inflammatory drugs from traditional medicinal plants without side-effects.

Lannea microcarpa Engl. & K. Kraus (Anacardiaceae) is a wild fruit tree found in savannas and Sudanian regions [7]. The fruit and leaves of the plant are used as food and have useful therapeutic properties for the treatment of diseases such as bacterial infection, inflammation, hypertension, cough, scurvy and rickets [8, 9, 10]. The seed oil is edible and is used in cosmetic products for the manufacture of hair care [11]. Previous studies on extracts of fruit and leaves of *Lannea microcarpa* showed good levels of flavonoids and polyphenols, as well as interesting antioxidant and antibacterial activities [12]. Leaves extracts of *Lannea microcarpa* had shown a topical anti-inflammatory activity and actives compounds such as myricetin 3-O-alpha-L rhamnopyranosid, vitexin, isovitexin, gallic acid and epicatechin [13]. The objectives of this study are to assess the anti-inflammatory activity of fruit and leaves extracts of *Lannea microcarpa*, and to elucidate the possible anti-inflammatory mechanism.

MATERIALS AND METHODS

Plant material

The fruit and leaves of *Lannea microcarpa* were collected in the botanical garden of Gonse (Lat/Long N 12°26. 624/ W 001°18.817, Kadiogo Province, Burkina Faso) and authenticated by Professor Jeanne Millogo. A herbarium specimen (No.003/B) was deposited in the herbarium of the University of Ouagadougou. Fresh fruit were stored in a freezer at 4°C before use, while the leaves were dried at room temperature and subsequently pulverized and stored in a bag before utilization.

Animals

NMRI mice (25-30g of weight and 8 to 12 weeks of age), obtained from the Health Science Research Institute of Burkina Faso were maintained under a cycle of 12 hours of light and 12 hours of dark with free access to food pellets and water. The protocols are already approved by the Institute of Health Science Research (Burkina Faso) and met the international standard of animal study [14].

Reagents

Allopurinol, sodium chloride (NaCl), carrageenan, soybean lipoxygenase type IB, quercetin, sodium phosphate dibasic (Na2HPO4), sodium phosphate monobasic (NaH2PO4), sodium carbonate (Na2CO3), silymarin, thiobarbituric acid, xanthine oxidase from bovine milk and xanthine (2.6 Dihydroxypurine) were obtained from Sigma-Aldrich (USA). Ascorbic acid, potassium hexacyanoferrate K3Fe (CN)6, and ferric chloride (FeCl3) were provided by Labosi (France). Acetone, n- hexane, dichloromethane, ethyl acetate, n-butanol were obtained from Fluka (Germany).

Extraction

Fifty grams (50 g) of fruit were crushed with the grain using a grinder (Microton 550 MB). Then, the paste was extracted with acetone (70%) for 24 hours using an electric mixer. Fifty grams (50

g) of leaves powder of *Lannea microcarpa* were extracted with acetone (80%) following the same procedures as with the fruit. The solutions obtained were filtered through Whatman paper No. 1, concentrated using a rotary evaporator and lyophilized with Telstar cryodos 50. A portion of the lyophilized material obtained was fractionated by successive liquid-liquid partitioning with n-hexane, dichloromethane, ethyl acetate and n-butanol. The ethyl acetate and n-butanol fractions, as well as hydro-acetonic extracts, was used for the tests.

***In vivo* tests**

Acute toxicity study

The acute toxicity test, by the oral route, of hydro acetonic extracts of fruit and leaves of *Lannea microcarpa* was performed according to the OECD-423 (Organization for Economic Cooperation and Development) procedure with some modifications [15]. NMRI mice (n=6) were used to perform the test. Doses of 500 mg/kg, 1000 mg, 1500 mg/kg and 2000 mg/kg body weight (b. w.) of extract from fruit and leaves were administered orally to mice kept in fast for 12 hours with access to water. After administration of the extracts, the number of animals which died after 24, 48 and 72 hours is counted. Surviving animals were observed for seven days in order to identify any signs of toxicity.

Carrageenan-induced paw edema test

The test was performed according to the method described by Winter et al. [16], with some slight modifications. NMRI mice of both sexes were used to measure the volume of the right hind paw, with a plethysmometer (UGO Basile 7140, Italy). The animals were divided into eight groups of six (3 males and 3 females). Group 1 mice was used as negative control and received orally distilled water (250 µl*). Group 2 mice received acetyl salicylic acid (150 mg/kg), as reference substance. Groups 3, 4 and 5 received orally respectively 100, 200 and 400 mg / kg of hydro-acetonic leaves extract. Groups 6, 7 and 8 received respectively 100, 200 and 400mg/kg of hydro-acetonic extract of fruit. After one hour, all mice were injected in the sole of the right hind paw, with 50µl of a solution of 1% carrageenan (NaCl 0, 9%). Paw edema volume was measured at time intervals of 1h, 3h, and 5h after carrageenan injection. The percentage inhibition of paw edema by the extracts, were calculated according to the equations below:

$$\text{Inhibition (\%)} = \left(\frac{(\text{Vt} - \text{V0})\text{control} - (\text{Vt} - \text{V0})\text{treated}}{(\text{Vt} - \text{V0})\text{control}}\right) \times 100$$

Vt is the paw volume at time t, V0 is the paw volume before carrageenan injection, (Vt – V0) is edema of treated animal, (Vt – V0) control is edema or paw size after carrageenan injection t_0 control mice at time t.

***In vitro* anti-inflammatory tests**

Lipoxygenase inhibition test

Inhibition of soybean lipoxygenase type 1-B was performed using the spectrophotometric method as described by Maiga et al. [17], with some modifications: 200 µl of enzyme solution (200 U / ml) were prepared in boric acid buffer (0.2 M, pH 9.0) and mixed with 50µl of plant extract solution (1 mg/ml in boric acid buffer). The resulting mixture was incubated for 3 min at room temperature. The reaction was initiated by addition of 250 ml of substrate solution (linoleic acid, 250 µM) and the rate of the reaction was read for 90 seconds at a wavelength of 234 nm. The boric acid buffer solution was used as a negative control (enzyme activity without inhibitor) and quercetin as a positive control. The percentage of inhibition of lipoxygenase by the different extracts was calculated according to the equation below:

$$\text{Inhibition (\%)} = \left(\frac{\text{V0 control} - \text{V0 sample}}{\text{V0 control}}\right) \times 100$$

V0 control is the activity of the enzyme without inhibitor, and V0 sample is the activity of the enzyme with the inhibitor.

Determination of the xanthine oxidase inhibition activity

The inhibition of xanthine oxidase activity was performed by spectrophotometric method as described by Owen & Timothy [18], with some modifications. The test mixture contained 150 µl of phosphate buffer (0.066 M, pH 7.5), 50 µl of extract solution (1 mg/ml in phosphate buffer) and 50 µl of the enzyme solution (0.28 U / ml). After 3 min of incubation at 25 ° C, the reaction was initiated by adding 250 ml of xanthine (0.15 M in 0.066 M phosphate buffer, pH 7.5). A control which consisted of a solution of xanthine oxidase was also prepared. The reaction was measured for 3 min at the wavelength of 295 nm and the initial speed V0 measured. Phosphate buffer was used as negative control (enzyme activity without any extract solution), and allopurinol as positive control. The percentage of xanthine oxidase inhibition was determined according to the equation described below:

$$\text{Inhibition (\%)} = \left(\frac{\text{V0 control} - \text{V0 sample}}{\text{V0 control}}\right) \times 100$$

Where V0 control is the enzyme activity without the inhibitor, and V0 sample is the activity of the enzyme with the inhibitor

In vitro antioxydant activities studies

Determination of the reducing power of extracts

Test of iron reduction by extracts of fruit and leaves of *Lannea microcarpa* was performed according to the protocol described by Hinneberg et al. [19]: 1 ml of extract dissolved in phosphate buffer (0.1 mg / ml) was mixed with 2.5 ml of phosphate buffer (0.2 M, pH 9.0) and 2.5 ml of an aqueous solution of potassium hexacyanoferrate 1%. After 30 minutes of incubation at 50°C, 2.5 ml of an aqueous solution of trichloroacetic acid was added to the reaction mixture and centrifuged at 3000 rpm for 10 minutes. The resulting supernatant was mixed with 2.5 ml of water and 0.5 ml of an aqueous solution of FeCl3 (0.1%), the absorbance of the reaction mixture thus obtained was read at the wavelength of 700 nm. A calibration plot was made with a solution of ascorbic acid. The reducing power of the extracts was expressed as an equivalent of ascorbic acid (EAA)/g.

Lipid peroxidation inhibition test

The lipid peroxidation inhibition test was performed according to the method described by Diplock et al [20] with some modifications. The reaction mixture comprised 100µl of extract (1mg/ml in a 10 mM phosphate buffer) or extract fraction from plant material (Leaves and fruit) or reference substance (silymarin), 100 µl of a soya lecithin solution (10mg/ml in phosphate buffer 10 mM, pH 7.4), 100 µl of an aqueous solution of FeCl3 (40 mM), and 100µl of ascorbic acid. The mixture was incubated at 37 °C. After one hour of incubation, 1 ml of a mixture of TBA (0.375%) and TCA (15% in hydrochloric acid 0.25 N) was added to the reaction mixture. This mixture was then boiled for 15 min. After cooling, the mixture was centrifuged. The pink color, due to the formation of thiobarbituric substances was measured at the wavelength of 532 nm.

Determination of levels of β-carotene and lycopene

Levels of β-carotene and lycopene in extracts of fruit and leaves of *Lannea microcarpa* were determined by the method described by Barros et al. [21]. 100 mg of lyophilized extract were dissolved in 10 ml of a mixture of acetone and hexane (4:6). The resulting solution is stirred vigorously for 1 min, and filtered through a membrane filter (Whatman paper No. 1). The absorbance of the filtrate was measured with a spectrophotometer, at wavelengths of 453, 505 and 663 nm. The contents of the extracted β-carotene and lycopene were calculated by using the following equations:

$$\text{Lycopene}\left(\frac{\text{mg}}{100\text{ml}}\right) = -0.0458\ \text{A663} + 0.372\ \text{A505}$$

$$\beta\ \text{carotene}\left(\frac{\text{mg}}{100\text{ml}}\right) = 0.216\ \text{A663} - 0.304\ \text{A505} + 0.452\ \text{A453}$$

Statistical analysis

All the tests were performed in triplicate, and data are presented as mean ±SEM. Analyses were done by using XLSTAT 7.1 software. The statistical analysis was performed by one way ANOVA followed by Tukey (HSD) multiple comparison test. A p value less than 0, 05 was used as the criterion for statistical significance.

RESULTS

Carrageenan induced paw edema in mice

Extracts of fruit and leaves at doses greater than 2000 mg / kg, showed no signs of toxicity or mortality. The results for the effects of hydro-acetonic extracts of fruit and leaves on the carrageenan induced edema in the right paw of mice are shown in table 1.

The injection of carrageenan in the right hind paw of the control group and test mice, produced, after one hour, an edema which gradually increased to a maximum, three hours after the injection of carrageenan, then began to decrease. Different doses of leaves extracts showed a significant inhibition ($P < 0.05$) at the third hour of inflammation; the pronounced effect was obtained at the fifth hours after carrageenan injection, compared to the control group. Different doses of fruit extracts produced a very significant inhibition ($P < 0.001$) of inflammation, with maximum inhibition obtained at the fifth hour of inflammation. The anti-inflammatory activity of *Lannea microcarpa* fruit and leaves extracts was dose-dependent at each time point (1h, 3h, and 5h). Acetylsalicylic acid, reference substance used in the treatment of inflammation, produced a clear inhibition of inflammation compared to control group. Among the sets of different doses of extract tested, those of 200mg/kg of fruit extracts produced the greatest inhibition of inflammation (78.44 %), followed respectively by doses of 400mg /kg and 100mg/kg of the extract. The leaves extract produced a slight inhibition of inflammation, as compared with fruit extracts. However, we noted an inhibition of 58.02 % obtained with a dose of 200 mg / kg. The leaves extract (200mg/kg) and acetylsalicylic acid (150 mg/kg) presented similar activities ($p > 0.05$).

Table1: Effect of administration of hydro acetone extract on carrageen in induced hind paw edema

Samples	Dose (mg/kg)	Increase in paw volume (mL), values between parenthesis (%) are inhibitory effect		
		1h	3h	5h
D W		0.263±0.042	0.363±0.065	0.428±0.058
Leaves	100	0.253±0.032	0.324±0.024* (14.92)	0.243±0.077** (41.75)
	200	0.238±0.042	0.208±0.074** (45.37)	0.185±0.057** (58.02)
	400	0.237±0.054	0.248±0.064* (35.02)	0.245±0.055** (44.40)
Fruit	100	0.157±0.08*(40.75)	0.207±0.06** (45.58)	0.153±0.074** (65.33)
	200	0.117±0.022**(56.03)	0.143±0.024** (62.41)	0.095±0.018** (78.44)
	400	0.164±0.020* (37.55)	0.127±0.086** (65.08)	0.129±0.022** (69.91)
ASA	150	0.100±0.010**(61.39)	0.140±0.018**(60.95)	0.140±0.016** (68.48)

*P < 0.05; **P <0.001Significant from control (one way ANOVA analysis followed by Tukey test), ASA: acetyl salicylic acid, DW: distilled water

In vitro anti-inflammatory activity of the extracts

The anti-inflammatory activity of extracts of *Lannea microcarpa* was evaluated with the test of inhibition of 15-lipoxygenase and xanthine oxidase which are both enzymes involved in inflammatory processes.

The extract of the leaves (and its fractions) produced the strongest inhibition of xanthine oxidase (table 2). No significant difference was observed between leaves extract and its fractions, while there was a significant difference ($P < 0.05$) between fruit extract and its fractions, with maximum inhibition obtained with ethyl acetate fraction (61.11± 3.64%). The extract of the leaves (and its fractions) also produced the strongest inhibition of lipoxygenase. There was a significant difference ($P < 0.05$) between the leaves extract and its fractions on the one hand, and the fruit extract and its fractions on the other hand, for this activity. Here we can note an increased inhibition obtained with the extract fractions: 83.30±0.69 and 89.98±00.61%, respectively with the ethyl acetate and n-butanol fractions of leaves extract, and 24.03±4.76 and 31.36±6.67 % respectively for ethyl acetate and n-butanol fractions of fruit extract. Allopurinol (100 µg/ml), a reference substance used in the test for inhibition of xanthine oxidase, produced an inhibition of 96.42±0.60 %, and quecetine (50µg/ml) produced an inhibition of 52.74±1.72% against lipoxygenase.

Table 2: Lipoxygenase and xanthine oxidase inhibitory effect (%) from *Lannea microcarpa* fruit and leaves extract and fractions

Extract (100µg/ml)	Enzyme inhibitory activities (%)	
	Xanthine oxidase	Lipoxigenase
HAE le	86.51±4.96^{a}	73.17±0.14^{b}
EAF le	91.27±5.5^{a}	83.30±0.69^{a}
BF le	82.54±1.37^{a}	89.98±±0.61^{a}
HAE fr	48.41±2.96^{bc}	21.32±1.86^{d}
EAF fr	61.11±3.64^{b}	24.03±1.76^{c}
BF fr	44.44±1.00^{c}	31.36±2.67^{c}
Allopurinol(100 µg/ml)	96.42±0.60	ND
Quercetin(50 µg/ml)	ND	52.74±1.72

Values are expressed as mean±SEM (n=3), ^{a,b} Mean values within a column with unlike superscript letters were significantly different (at P<0,05). According to analysis of variance, HAE: Hydroacetonic extract.

EAF: Ethyl Acetate Fraction, BF: n-Butanol Fraction, fr: fruits, le: leaves, ND: Not determined.

Antioxidant activities

Reducing power

Ascorbic acid was used as the reference compound. It can be observed that the reducing power (table 3) ranges from 0.40±0.02 to 0.76± 0.02 mg AAE/100 mg for fruit extract and its fractions, and 3.78±0.09 to 9.46±0.26 for leaves extract and its fractions. We notice a weak reducing power of the ethyl acetate and n-butanol fractions compared to that of the hydro-acetonic extract.

Inhibition of lipid peroxidation

The percentage inhibition of lipid peroxidation by the extracts at concentration (1 mg/ml) are showed on table 3 and ranges from 21.94±1.75% to 34.58±3.30% for extracts and extracts fractions of fruit; and from 50.80±0.66 to 78.07±4.35% for extracts and extracts fraction of leaves. Silymarin (1mg/ml) has produced an inhibition of 54.29±0.30% of lipid peroxidation. Inhibition of lipid peroxidation by silymarin is less strong than the one obtained with ethyl acetate and butanol fractions of the leaves. Compared to the

fruit, the leaves extract and its fractions produced a better activity for both the inhibition of lipid peroxidation and the reduction of ferrous ions. The results also show a decrease in the reducing power of ethyl acetate fraction and n-butanol fraction with both leaves and fruit extracts, compared to both fruit and leaves hydro-acetonic extracts.

Table 3: Antioxidant power from *Lannea microcarpa* fruit and leaves extract and fractions

Extract	Antioxidant	
	FRAP (mg AAE/100 mg)	Lipid peroxidation (%)
HAE le	9.46±0.26[a]	50.80±0.66[b]
EAF le	3.78±0.09[b]	78.07±4.35[a]
BF le	3.90±0.03[b]	74.49±5.28[a]
HAE fr	0.76±0.02[c]	21.94±1.75[d]
EAF fr	0.40±0.02[d]	32.85±0.35[c]
BF fr	0.44±0.01[c]	34.58±3.30[c]
Silymarin	ND	54.29±0.30
A A	100±2.64	ND

Values are expressed as mean±SEM (n=3), [a,b] Mean values within a column with unlike superscript letters were significantly different (P<0,05). According to analysis of variance, AA: Ascobic Acid, HAE: Hydroacetonic extract, EAF: Ethyl Acetate Fraction, BF: n Butanol Fraction: Butanol. fr: fruit, le: leaves, ND: Not determined.

Carotenoids content of the extracts

Levels of β-carotene and lycopene in the extracts from fruit and leaves are shown on figure1. High levels of carotenoids content was obtained with hydro-acetonic extracts of leaves (0.106±0.010 and 0.067±0.004 mg / g of dry extract respectively for β carotene and lycopene) compared to the fruit extract (0.076±0.006 and 0.048±0.002 mg/g of dry extract respectively for β carotene and lycopene).

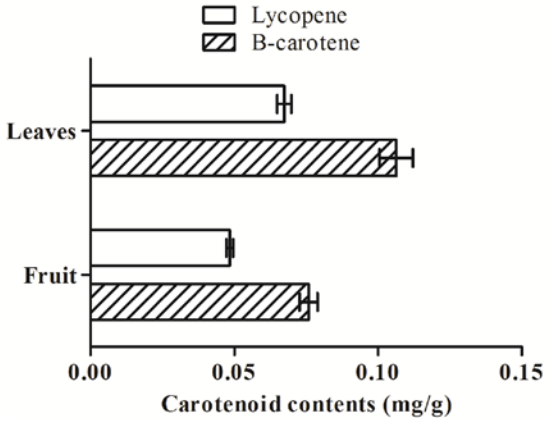

Fig. 1: Carotenoid contents of Lannea microcarpa fruits and leaves extracts

DISCUSSION

The hydro-acetonic extract of fruit or leaves of *Lannea microcarpa*, when administered up to a dose of 2000 mg/kg, produced no visible side effect or death. This once again confirms the low toxicity of *Lannea microcarpa* leaf extracts as formely evidenced on human epidermal cells [13]. The range of doses used for the evaluation test of acute inflammation inhibition, has been chosen to be tolerable for the treated animals.

The model of carrageenan-induced paw edema is sensitive to most anti-inflammatory agents clinically effective [22]. In the present study, an investigation has been made to evaluate the anti-inflammatory activity of *Lannea microcarpa* using the carrageenan-induced paw oedema model. The result of this investigation indicates that hydro-acetonic extracts of *Lannea microcarpa* fruit and leaves inhibited acute inflammation induced by carrageenan.

The acute inflammation induced by carrageenan, release endogenes mediators which involve two essential phases which are separated by a transient phase. The early phase is mediated by the release of histamine and serotonin, whereas the late phase is associated with neutrophil infiltration, the release of eicosanoids, production of free radicals and the release of mediators from other neutrophils [23]. The edema, produced between the early phase and the late phase, is probably due to the release of kinins such as bradykinin and kallidin, which induces later the biosynthesis of prostaglandins and other autacoids [24]. It is well known that expressions of COX-1 and 2 are greatest during the period running from the intermediate phase to the late phase, after injection of carrageenan [25]. Extracts of fruit and leaves have produced a greater inhibition of edema formation (induced by carrageenan), during the intermediate and the late phase (3h and 5h), with a maximum inhibition observed in the late phase (5th hour). These observations indicate that hydro- acetonic extracts of fruit and leaves of *Lannea microcarpa* may affect COX 1 and 2. Our results are in agreement with those obtained in the study of the anti-inflammatory activity of *trichosanthes cucumerina* Linn through inhibition of carrageenan-induced paw edema in rat. This anti-inflammatory activity is dose-dependent. (1h: r 2 = 1; 3h: r 2 = 1; 5h: r 2 = 1) at each time point and maximum at the 5 th hour after the injection of carrageenan. Xanthine oxidase is a flavoprotein that catalyzes the oxidation of hypoxanthine to xanthine, so generating uric acid and superoxides [26]. Xanthine oxidase has been demonstrated to be an important generator of toxic oxygen metabolites in acute inflammation [27].

The hydro-acetonic extract of fruit and leaves of *Lannea microcarpa* has inhibited xanthine oxidase, less than the fractions. Previous studies indicated the high content of anthocyanins, flavonoid and polyphenol in the polar fractions of fruit and leaves of *Lannea microcarpa* [28]. The reduction of formation of uric acid by flavonoids and anthocyanins, through inhibition of Xanthine oxidase has been proven [29]. Xanthine oxidase inhibitory effect of *Lannea microcarpa* leaves extract and its fraction is comparable to that of chloroform extract of leaves of *Erythrina stricta* Roxb.(100µg/ml) with 84.75±00.54 % of inhibitory effect [30]. The ethyl acetate and n-butanol fractions of extracts of fruit and leaves of *Lannea microcarpa* were also more efficient in lipoxygenase inhibition than the crude extract. Lipoxygenases are enzyme involved in inflammatory processes and oxidative stress because their activation generates lipid peroxides and biosynthesis of inflammatory lipid mediators [31]. The results obtained from this study, also indicated the antioxidant capacities of the extracts of fruit and leaves of *Lannea microcarpa*. The significant antioxidant activity from the extracts of fruit and leaves of *Lannea microcarpa* can be attributed to their higher carotenoid content, since carotenoids such as β-carotene and lycopene are known to exert significant antioxidant activity [32]. Compared to carotenoid content of carrot (1,030 mg/g) and that of tomato (0,2431mg/g) reported by [33], the extract of *Lannea microcarpa* may serve as carotenoids potential sources. Our finding suggests that the content in polyphenol and carotenoids of *Lannea microcarpa* might contribute to the inhibition of the activities of pro-oxidant enzymes like xanthine oxidase and

15-lipoxygenase. Polyphenols (phenolic compounds and flavonoids) are the plant secondary metabolites which exert a significant antioxidant activity mainly due to their redox properties [34] and may play an important role in scavenging free radicals and reducing oxygen species and peroxides. Indeed, flavonoids are well- known inhibitors of xanthine oxidase and lipoxygenase [35]. Flavonoids and phenolic acids have anti-inflammatory and analgesic properties in animal models [36]. Studies have also shown the antioxidant power of carotenoids and their importance in human nutrition through their pro-vitamin A property [37]. These findings justify the use of the extracts of leaves and fruit of *Lannea microcarpa* in formulations of cosmetic products used for skin and hair care [38]. The anti-inflammatory and antioxidant activities of the leaves and fruit extracts of *Lannea microcarpa* could be due to the presence of polyphenol compounds (including flavonoids), and also that of apolar compounds such as carotenoids.

CONCLUSION

The results obtained from the present study support the traditional use of fruit and leaves of *Lannea microcarpa* in the management of inflammatory diseases and also as food additives for treatment of scurvy and rickets. Bio-guided fractionation could help isolate and identify the most active compounds in order to elucidate the mechanism of action on different inflammatory mediators.

CONFLICT OF INTEREST

Authors declare no conflict of interest

ACKNOWLEDGEMENT

We gratefully acknowledge International Foundation for Science (IFS) for their financial support- E/4811-1.

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