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Studies of Phenolic Constituents and Biological Activities of *Livistona decipiens* Leaves (Fam. Arecaceae).

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ABSTRACT

This study focused on isolation and identification of secondary metabolites from the alcoholic extract of *Livstona decipiens* leaves for the first time, as well as evaluation of its biological activities. The *n*-butanol extract was subjected to polyamide 6 column chromatography and ten flavonoids were isolated, the isolated compounds were identified as; Schaftoside (**1**), Isoorientin (**2**), Tricin-7-O-glucoside (**3**), Quercetin (**4**), Luteolin (**5**), Orientin (**6**), Luteolin-7-O-glucoside (**7**), Quercetin-3-O-galactoside (**8**), Apigenin (**9**) and Tricin (**10**), and their structures were established on the basis of different spectroscopic techniques. Antioxidant, analgesic, anti-inflammatory and antihyperglycemic activities of the extracts were evaluated. Determination of the median lethal dose (LD_{50}) revealed that the extracts of the plant are safe and no lethality was observed up to 24 hours after treatment. The ethanolic extract was found to exhibit remarkable analgesic, antihyperglycemic and anti-inflammatory, while *n*-butanol extract showed significant antioxidant activity, so this plant is a new source for phenolic compounds and due to its low toxicity, it is an effective medicinal agent for the use in the treatment of human diseases.

Keywords: *Livistona decipiens*, Flavonoids, Analgesic, Antihyperglycemic, Anti-inflammatory, Antioxidant

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INTRODUCTION

Arecaceae is one of the best known plant families, which also called Palmae, they comprises 181 genera with around 2600 species . Most palms are distinguished by their large evergreen leaves, known as fronds, arranged at the top of an unbranched stem. Palms exhibit an enormous diversity in physical characteristics and inhabit nearly every type of habitat within their range, from rainforests to deserts [1]. The genus *Livistona* is widely cultivated in tropical areas as a landscaping tree; it is a genus of 36 species native to southern and southeastern Asia, Australasia, and the Horn of Africa [2]. There are about four *Livistona* species in Egypt namely *Livistona australis*, *L. chinensis*, *L. decipiens* and *L. rotundifolia* and three species are growing in South China [3]. They have been traditionally used for analgesic, haemostatic, anti-nasopharyngeal carcinoma, antichoriocarcinoma, antiesophageal cancer, and antileukemia [4]. The oil of the dried pulps of *Livistona decipiens* has antihyperlipidemic and anti-ulcer activities [5]. Previous chemical investigations on this genus reported the presence of steroids, amino acids, vitamins, fatty acids and phenolics [6-9]. *Livstona decipiens Becc*. is endemic to Australia and grows along forest edges and coastal swamps in eastern Queensland. It prefers full sun but can tolerate partial shade and it can reach heights of 30 to 50 feet [10]. Little has been reported on *L. decipiens* Becc. and this study aims to isolate the chemical constituents of *Livistona decipiens* leaves and evaluation their biological activities.

MATERIALS AND METHODS

General procedure

NMR spectra were recorded on a Varian MR 400 NMR spectrometer (Japan) at 400 MHz for ^{1}H and 100 MHz for ^{13}C-NMR. ESI-MS were recorded by a Bruker APEX II mass spectrometer, Hiroshima University (Japan). Paper chromatographic analysis (PC) and preparative paper chromatographic separation were carried out on Whatman No.1 and 3 MM papers respectively, using solvent systems 15% HOAc and BAW (n-BuOH-HOAc-H2O, 4:1:5, upper layer).

Plant Material

The leaves of *L. decipiens* Becc. (Fam. Arecaceae) were collected from El–Orman Botanical Garden, Giza, Egypt and identified by Dr. M. Elgebaly Former Researcher of Taxonomy, NRC and Consultant at Central Administration of Plantation and Environment according to the New Royal Horticultural Society dictionary of gardening [11]. A voucher specimen (No.M-139) was deposited at the herbarium of the National Research Centre (Giza, Egypt).

Extraction and isolation

Two kg of air–dried powdered leaves of *L. decipiens* Becc*.* were extracted with 70% ethanol till exhaustion, then evaporated under reduced pressure to yield 250 g of a brown residue that was suspended in water (1000 ml) and partitioned successively with petroleum ether, chloroform and *n*-butanol. The successive extracts were separately evaporated under reduced pressure to yield 25 g, 23 g and 112.5 g respectively. The *n*-butanol extract was subjected to polyamide 6 column chromatography which was eluted with distilled water then followed by mixtures of water/ methanol of decreasing polarities. Finally, the column was eluted with absolute methanol to ensure a perfect elution process. The similar fractions were collected to give five major fractions (I: V). Fraction II (1.2 g) was subjected to Sephadex LH-20 CC using 50% methanol yielding a pure compound **1** (40 mg). Fraction III (1.5 g) was applied on Sephadex LH-20 CC using saturated *n*-butanol as eluent yielding two subfractions 1 and 2. The two subfractions were separately fractionated on Sephadex LH-20 CC using 70% methanol giving two pure compound **2** (25 mg) and **3** (30 mg). Fraction IV (3 g) was loaded on Sephadex LH-20 CC using mixture of water/methanol yielding two subfractions, each of them was subjected to Sephadex LH-20 CC using water as eluent yielding five pure compounds **4** (35 mg), **5** (25 mg), **6** (30 mg), **7** (20 mg) and **8** (25 mg). Fraction V was purified on Sephadex LH-20 CC using 80% methanol afford two pure compounds **9** (30 mg) and **10** (15 mg).

Animals

Adult male Albino rats of Sprague Dawely Strain of 130-150 g body weight and albino mice of 25-30 g body weight. Animals were obtained from the animal House of National Research Centre, Dokki, Giza, Egypt. They were fed on standard laboratory diet composed of vitamin mix (1 %), mineral mix (4 %), corn oil (10 %), sucrose (20 %), cellulose (0.2 %), casein (10.5 %) and starch (54.3 %). [12, 13]

Ethical issues

All animals were kept under the same hygienic conditions and on a standard laboratory diet. All procedures concerning animals, treatment and experimentation were in accordance with the Guiding Principles in the Care and Use of Animals and were approved by the Experimental Animal Research Committee, NRC, Egypt.

Chemicals and kits

Indomethacin (Epico, Egyptian Int. Pharmaceutical Industries Co., A.R.E.) as standard anti-inflammatory and analgesic, Metformin (Cidophage); (Chemical Industries Development CID, Giza, as standard antihyperglycemic drug, Vitamin E (*dl*-α- tocopheryl acetate) as a standard antioxidant, Carrageenan (Sigma Co.) was used for the induction of acute inflammation in rats. Alloxan (Sigma Co.) for the induction of diabetes, Glutathione kit (Wak Company-Germany) for the assessment of antioxidant activity and BioMerieux kits for the assessment of blood glucose level.

Evaluation median lethal dose (LD_{50})

Groups of 10 mice of both sexes (20 – 30 g) were used. Several doses at equal logarithmic intervals were chosen, each dose was injected in a group of 10 animals by subcutaneous injection. The mice were then observed for 24 h and symptoms of toxicity and mortality of rats in each group were recorded and the LD_{50} calculated using the following equation [14].

$$\mathbf{LD_{50} = D_m - \Sigma (Z \times d) / n}$$

D_m = Highest dose which kills all animals in the groups
Z = the mean of dead animals in two successive groups
d = the constant factor between two successive groups
n = the number of animals in each of the dose levels

Evaluation of antioxidant activity

The antioxidant activity was determined by measuring the GSH level in blood of alloxan-induced diabetic rats upon administration of the different extracts for one week [15, 16]. Sixty six rats were divided into eleven groups (six animals each). One group was kept as a negative control and received 1 ml saline while diabetes was induced in the other groups by a single intraperitoneally administration of alloxan at a dose of 150 mg/ kg bodyweight (BW) followed by an overnight fast. Blood samples were collected from the retro-orbital venous plexus of each rat and the blood glucose level was measured to confirm induction of diabetes using BioMe´rieux kits [17]. Diabetic rats were divided into nine groups. The first group was kept untreated served as positive control that received 1ml saline and the second group was given the 50 mg/ Kg of 70% ethanolic extract in oral doses, the third group received 100 mg/ Kg of 70% ethanolic extract, the fourth group received 50 mg/ Kg of hexane extract, the fifth group received 100 mg/ Kg of hexane extract, the sixth group received 50 mg/ Kg of chloroform extract, the seventh group received 100 mg/ Kg of chloroform extract, the eighth group received 50 mg/ Kg butanol extract, the ninth group received 100 mg/ Kg butanol. The last group received the reference drug (vitamin E, 7.5 mg/ kg BW in an oral dose). After seven days, blood samples were collected from the rats. At the end of the experiment, blood samples were obtained and blood GSH level was measured using GSH kit [Elman's reagent, 5, 5-dithio bis-(2-

nitrobenzoic acid), to yield a stable yellow color which can be measured colorimetrically at 412 nm]. The intensity of the yellow color developed is directly proportional to the amount of GSH in blood.

Calculation: Glutathione (GSH) concentration in blood = A_{sample}x 66.66 mg/dl

Evaluation of analgesic activity

Animals were acclimatized to the laboratory conditions for at least 1 h before testing and were used once during the experiment. Acetic acid induced writhing test [18]. Animals were divided into ten groups, the first group was served as positive control, the Second group received 50 mg/ Kg of 70% ethanolic extract, the third group received 100 mg/ Kg of 70% ethanolic extract, the fourth group 50 mg/ Kg of hexane extract, the fifth group received 100 mg/ Kg of hexane extract, the sixth group received 50 mg/ Kg of chloroform extract, the Seventh group received 100 mg/ Kg of chloroform extract the eighth group received 50 mg/ Kg of butanol extract, the ninth group received 100 mg/ Kg of ethanol extract of and the tenth group received 20 mg/ Kg of Indomethacin as reference drug, 30 min later 0.6% acetic acid was injected intraperitoneally (0.2 ml/ rat) then each rat was placed in an individual clear plastic observe chamber and the total number of abdominal constrictions was counted each 15 min was counted for each mouse.

Evaluation of acute anti-inflammatory activity

This effect was determined according to the method described by [19]. Sixty male albino rats, weighing 130- 150 g were divided into ten groups, each of six animals, the first group received 1 ml of saline serving as control, from the Second group to ninth group received the required doses from the extracts with the same sequence as mentioned before in the previous test while the tenth group received 20 mg/ Kg of indomethacin as a reference drug. One hour later, all the animals received a sub plantar injection of 0.1 ml of 1% carrageenan solution in saline in the right hind paw. After drug administration edema thickness was measured by the caliber. The percentage of edema was calculated as follows:

$$\%\text{Edema} = \frac{\text{Paw diameter after carrageenan} - \text{Paw diameter before carrageenan}}{\text{Paw diameter before carrageenan}} \text{ x } 100$$

Evaluation of antihyperglycemic activity

Male albino rats of the Sprague Dawely Strain (130- 140 g) were injected intraperitoneally with alloxan (150 mg/ kg body weight) to induce diabetes mellitus [16]. Hyperglycemia was assessed by measuring blood glucose after 72 h and after 2 and 4 weeks intervals. Animals were divided into ten groups. First group diabetic rats served as positive control, Second group received 50 mg/ Kg of 70% ethanolic extract, the third group received 100 mg/ Kg 70% ethanolic extract, the fourth group 50 mg/ Kg of hexane extract, the fifth group received 100 mg/ Kg of hexane extract, the sixth group received 50 mg/ Kg of chloroform extract, the Seventh group received 100 mg/ Kg of chloroform extract the eighth group received 50 mg/ Kg of butanol extract the ninth group received 100 mg/ Kg of butanol extract and the tenth group received 100 mg/ Kg of Cidophage (metformin) as reference drug. At the end of each study period, blood samples were collected from the retro orbital venous plexus though the eye canthus of anaesthetized rats after an overnight fast. Serum was isolated by centrifugation and the blood glucose level was measured [17].

Statistical Analysis

The obtained data were analyzed by using the student ``t`` test [20].

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RESULTS AND DISCUSSION

Identification of isolated compounds

Structure elucidation of the pure isolated phenolic compounds were performed using different spectroscopic techniques; ^{1}H-NMR, ^{13}C-NMR and ESI-MS spectrometry, and their structures were confirmed by comparing their data with those previously published in literature. Structures were identified to be six flavonoid glycosides, Schaftoside [21], Isoorientin [22], Tricin-7-*O*-glucoside [23], Orientin [24], Luteolin-7-*O*-glucoside [25], Quercetin-3-*O*-β-D-galactopyranosid [26] and four aglycones: Quercetin [22], Luteolin [25], Apigenin [27] and Tricin [28] which have been isolated for the first time from *L. decipiens* leaves.

Spectroscopic data of some isolated compounds

Apigenin-6-C-glucosyl-8-C-arabinoside (Schaftoside) **1** was isolated as a yellow amorphous powder soluble in methanol. ESI-MS at *m/z* 563 [M-H]$^{-}$. ^{1}H-NMR *δ (ppm)*: (DMSO-d_6, 400 MHz), 7.90 (2H, *d*, *J* = 8.5 Hz, H-2', H-6') , 6.95 (2H, d, *J* = 8.5 Hz, H-3', H-5') and 6.88 (H-3,s) *Sugar moiety δ (ppm)*: 4.76 (1H, *d, J* = 9.1Hz, H-1″), 4.73 (1H, *d, J* = 9.1Hz, H-1‴), 3.12-3.97 (10 H, m, H-2″- H-6″ and H-2‴- H-6‴) (*β-D*-glucoside and *α-L*-arabinoside). ^{13}C-NMR *δ (ppm)*: (DMSO-d_6, 100 MHz) 181.5 (C-4), 163.2 (C-2), 162.5 (C-7) and 160.5 (C-4′), 158.2 (C-5), 155 (C-9), 128.3 (C-6′ and C-2′), 121.5 (C-l`), 116 (C-3′ and C-5′), 108.5 (C-6), 104.7 (C-8), 102.72 (C-10), 102.18 (C-3). *Sugar moiety δ (ppm)*: 81.13 (C-5″), 78.53 (C-3″), 74.94 (C-3‴), 74.10 (C-1‴), 73.48 (C-1″), 72.40 (C-4″), 70.76 (C-2″), 70.55 (C-5‴), 68.9 (C-4‴), 68.65 (C-2‴), 61.30 (C-6‴), 60.78 (C-6″).

Tricin-7-O-β-D-glucopyranoside **3** was isolated as a yellow amorphous powder soluble in methanol. ESI-MS at *m/z* 491 [M-H]$^{-}$. ^{1}H-NMR *δ (ppm)*: (DMSO-d_6, 400 MHz) 7.28 (2H, s, H-2′, 6′), 7.00 (1H, *s,* H-3), 6.86 (1H, *d, J* = 2 Hz, H-8), 6.39 (1H, *d, J* = 2 Hz, H-6), 3.81 (6H, s, 3`, 5`- OMe). *Sugar moiety δ (ppm)*: 4.98 (1H, *d, J* = 7.3 Hz, H-1″), 3.1- 3.7 (5H, m, H-2″- H-6″). ^{13}C-NMR (DMSO-d_6, 100 MHz): 182.1 (C-4), 164 (C-2), 163.2 (C-7), 161.2 (C-5), 157.1 (C-9), 148.50 (C-3`, 5`), 141.80 (C-4`), 121 (C-1`), 105.80 (C-10), 104.9 (C-2`, 6`), 104 (C-3), 99.80 (C-6), 95.80 (C-8), 56.80 (3, 5`-OMe). *Sugar moiety δ (ppm)*: 100.60 (C-1``), 77.80 (C 5``), 76.90 (C-3``), 73.6 (C-2``), 70.10 (C-4``), 61.0 (C-6``).

Quercetin-3-O-β-D-galacopyranoside (Hyperin) **8** was isolated as a yellow amorphous powder soluble in methanol. ESI-MS at *m/z* 463 [M-H]$^{-}$.^{1}H-NMR *δ (ppm)*: (DMSO-d_6, 400 MHz) 7.65 (*dd*, *J* = 2.1 Hz & 8.6 Hz, H-6′), 7.51 (*d*, *J* = 2.1 Hz, H-2′), 6.80 (*d*, *J* = 8.62 Hz, H-5′), 6.38 (*d, J* = 1.8 Hz, H-8), 6.17 (*d, J* = 1.8 Hz, H-6). *Sugar Moiety δ (ppm)*: 5.36 (*d, J* = 7.6 Hz, H-1″), 3.19-3.62 (*m*, H-2″-H-6″). ^{13}C-NMR *δ (ppm)*: (DMSO-d_6, 100 MHz) 177.50 (C-4), 164.30 (C-7), 161.70 (C-5), 156.30 (C-2), 156.20 (C-9), 148.80 (C-4'), 144.90 (C-3'), 133.00 (C-3), 122.00 (C-6'), 121.10 (C-1′), 116.00 (C-5'), 115.10 (C-2'), 103.50 (C-10), 98.80 (C-6), 93.60 (C-8), *Sugar Moiety δ (ppm)*: 102.00 (C-1″), 76.00 (C-5''), 73.30 (C-3″), 71.10 (C-2″), 67.90 (C-4''), 60.00 (C-6'').

Biological assessments

The 70% ethanol, hexane, chloroform and *n*-butanol extracts were subjected to different biological evaluation studies. LD_{50} determination showed that the plant is safe and nontoxic as it doesn't induce mortality up to 24 hours after treatment. It could be considered that 70% ethanolic extract is safe up to 6.4 g/ kg.

Antioxidant activity

The result shown in Figure 1 revealed that *n*-butanol extract (100 mg/kg) possessed the highest antioxidant activity. The percentage of change is 4.1% compared to the control group. Its activity was nearer to the reference drug; vitamin E whose percentage of change is 1.4% followed by 70% ethanolic extract (100 mg/kg) with percentage of change 4.9% and 70% ethanolic extract (100 mg/ kg) with percentage of change 4.99% respectively. The least effective was hexane extract (50 mg/ kg) as shown in Table 1.

Analgesic activity

As shown in Figure 2 the 70% ethanolic extract (100 mg/kg) induced the most powerful analgesic effect with percentage of protection from abdominal constriction is 53.35%, while the percentage of protection of the reference drug Indomethacin from abdominal constriction is 61.09%. These results indicated that the 70% ethanolic extract of *L. decipiens* leaves (100 mg/kg) possessed reasonable analgesic activity followed by *n*-butanol extract (100 mg/kg) and *n*-butanol extract (50 mg/kg) respectively as shown in Table 2.

Acute anti-inflammatory activity

The anti-inflammatory activity of the extracts of *Livistona decipiens* leaves was tested after 1, 2, 3 and 4 hours intervals. The results Figure 3 revealed that the 70% ethanolic extract (100 mg/ kg) showed the most potent activity as it reduced the edema by 10.8 after 4 hours, it was as potent as the reference drug indomethacin (8% change) after 3 hours. The ethanolic extract (50 mg/ kg) exhibited potent anti-inflammatory activity with percentage of change 13.2%. The least effective extract was the hexane extract (100 mg/ kg) with percentage of change is 25.2% as shown in Table 3.

Antihyperglycemic activity

The antihyperglycemic activity of the extracts of *Livistona decipiens* leaves were tested after 2 and 4 weeks intervals. The results in Figure 4 revealed that the 70% ethanolic extract (100 mg/kg) showed a percentage of change in serum glucose level of 28.5% and 50.4% respectively. The rats treated with metformin showed a decrease in serum glucose level by 34.4% and 67.6% after 2 and 4 weeks respectively. The percentage of change of 70% ethanolic extract (100 mg /kg) after 4 weeks exceeds the reference drug after 2 weeks. It was evident from the presented results that the 70% ethanolic extract (100 mg/kg) possessed significally antihyperglycemic activity followed by butanol extract (100 mg/kg) with percentage of change 20.6%, 45.5% after 2 and 4 weeks respectively as shown in Table 4.

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Table 1: Antioxidant activity of 70% ethanolic extract, hexane extract, chloroform extract and *n*-butanol extract of *L. decipiens* leaves and vitamin E drug in male albino rats

Group	Blood glutathione (mg %)	%of change
Control (1ml saline)	36.7 ± 1.4	-
Diabetic	21.9 ± 0.6*	40.3
Diabetic + Vitamin E (7.5 m/ kg)	36.2 ± 1.1	1.4
Diabetic + 70% ethanolic extract (50 mg/ kg)	34.9 ± 1.1	4.9
Diabetic + 70% ethanolic extract (100 mg/ kg)	35.8 ± 1.2	4.99
Diabetic+ hexane extract (50 mg/ kg)	30.2 ± -0.6*	17.7
Diabetic + hexane extract (100 mg/ kg)	31.9 ± 0.8	13.1
Diabetic + chloroform extract (50 mg/ kg)	33.4 ± 0.9	8.99
Diabetic + chloroform extract (100 mg/ kg)	34.2 ± 0.7	6.8
Diabetic + *n*-butanol extract(50 mg/ kg)	34.5 ± 0.6	5.99
Diabetic + *n*-butanol extract(100 mg/ kg)	35.2 ± 1.3	4.1

Table 2: Analgesic activity of 70% ethanolic extract, hexane extract, chloroform extract and *n*-butanol extract of *L. decipiens* leaves and indomethacin drug on number of abdominal constriction

Group	Dose mg/ kg b.wt	Number of abdominal constriction	Reduction %
Control	1ml saline	47.8 ± 1.6	-
70% ethanolic extract (50 mg/ kg)	50	30.2 ± 1.1*	36.82
70% ethanolic extract (100 mg/ kg)	100	22.3 ± 0.9*	53.35
Hexane extract (50 mg/ kg)	50	38.1 ± 0.8*	20.29
Hexane extract (100 mg/ kg)	100	35.3 ± 1.5*	26.15
chloroform extract (50 mg/ kg)	50	36.4 ± 1.3*	23.85
chloroform extract (100 mg/ kg)	100	32.9 ± 1.2*	31.17
n-butanol extract (50 mg/ kg)	50	28.3 ± 0.7*	40.79
n-butanol extract (100 mg/ kg)	100	25.9 ± 0.8*	45.82
Indomethacin	20	18.6 ± 0.4*	61.09

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Table 3: Anti-inflammatory activity of 70% ethanolic extract, hexane extract, chloroform extract and *n*-butanol extract of *L. decipiens* leaves and indomethacin drug in male albino rats (n=6)

	Zero	1h			2h			3h			4h		
	Paw diameter (mm)	Paw diameter (mm)	edema thickness (mm)	% of edema thickness	Paw diameter (mm)	edema thickness (mm)	% of edema thickness	Paw diameter (mm)	edema thickness (mm)	% of edema thickness	Paw diameter (mm)	edema thickness (mm)	% of edema thickness
Control	3.42±0.09	4.61±0.1*	1.19	34.79	4.81±0.13*	1.39	40.64	4.89±0.12*	1.47	42.98	4.96±0.08*	1.54	45.02
70% ethanolic extract (50 mg/kg)	3.48±0.04	4.36±0.1*	0.88	25.28	4.21±0.1*	0.73	20.98	4.09±0.1*	0.61	17.52	3.94±0.07*	0.46	13.21
70% ethanolic extract (100 mg/kg)	3.51±0.07	4.26±0.1*	0.75	21.37	4.05±0.1*	0.54	15.38	3.96v0.09*	0.45	12.82	3.89±0.08*	0.38	10.82
Hexane extract (50 mg/kg)	3.39±0.01	4.59±0.02*	10.20	35.4	4.49±0.08*	1.10	32.44	4.43±0.07*	1.04	30.67	4.35±0.02*	0.96	28.31
Hexane extract (100mg/kg)	3.51±0.06	4.47±0.04*	0.96	27.35	4.45±0.03*	0.94	26.78	4.22±0.06*	0.91	25.92	4.30±0.04*	0.88	25.21

Statistically significant from control group at p. <0.01

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Table 3:cont.

	Zero	1h			2h			3h			4h		
	Paw diameter (mm)	Paw diameter (mm)	edema thickness (mm)	% of edema thickness	Paw diameter (mm)	edema thickness (mm)	% of edema thickness	Paw diameter (mm)	edema thickness (mm)	% of edema thickness	Paw diameter (mm)	edema thickness (mm)	% of edema thickness
Chloroform extract (50 mg/kg)	3.49±0.02	4.48±0.08*	0.99	28.36	4.44±0.03*	0.95	27.22	4.37±0.01*	0.88	25.21	4.30±0.04*	0.81	23.20
Chloroform extract (100 mg/kg)	3.35±0.03	4.18±0.01*	0.83	24.78	4.14±0.01*	0.79	23.58	4.10±0.03*	0.75	22.38	4.07±0.02*	0.72	21.49
***n*-butanol (50 mg/kg)**	3.35±0.01	4.11±0.02*	0.76	22.68	4.03±0.01*	0.68	20.29	4.00±0.01*	0.65	19.4	3.96±0.07*	0.61	18.2
***n*-butanol (100 mg/kg)**	3.41±0.07	4.06±0.03*	0.65	19.06	4.32±0.03*	0.61	17.88	3.96±0.01*	0.55	16.12	3.90±0.02*	0.49	14.36
Indomethacin	3.58±0.08	4.31±0.09*	0.73	20.39	4.02±0.06*	0.44	12.29	3.93±0.01*	0.35	9.77	3.87±0.01*	0.29	8

Statistically significant from control group at p. <0.01

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Table 4: Antihyperglycemic activity of 70% ethanolic extract, hexane extract, chloroform extract and *n*-butanol extract of *L.decipiens* leaves and metformin drug on blood glucose level in male albino rats

Group	Diab non treated	Diab. Treated with 70% ethanolic extract (50mg/ kg)		Diab. Treated with 70% ethanolic extract (100 mg/kg)		Diab. Treated with Hexane extract (50mg/kg)		Diab. Treated with Hexane extract (100mg/kg)		Diab. Treated with Metformin (100 mg/kg)	
	M±S.E	M±S.E	% of change	M±S.E	% of change	M±S.E	% of change	M±S.E	% of change	M±S.E	% of change
Zero	249.8 ± 7.2	255.1 ± 8.5	-	258.9±8.7	-	261.2±9.2	-	253.9±8.1	-	265.5±83.9	-
2w	257.9 ± 6.8	218.4 ± 7.9*	14.387	158.2±6.9*	28.467	225.4±7.5*	13.706	212.7±7.8*	16.227	174.3±6.2*	34.350
4w	265.7 ± 7.5	158.3 ± 6.9 *	37.946	128.4±4.8*	50.406	196.3±6.7*	24.847	181.5±6.3*	28.515	86.1±2.3*	67.571

Table 4 Cont.:

Group	Diab. Treated with chlorofom extract (50 mg/kg)		Diab. Treated with chloroform extract (100 mg/kg)		Diab. Treated with *n*-butanol (50 mg/kg)		Diab. Treated with *n*-butanol (100 mg/ kg)		Diab. Treated with Metformin (100 mg/kg)	
	M±S.E	% of change	M±S.E	% of change	M±S.E	% of change	M±S.E	% of change	M±S.E	% of change
Zero	249.1 ± 7.2	-	253.5±8.1	-	262.5±9.6	-	259.8±9.5	-	265.5±83.9	-
2w	222.3 ± 6.4	11.160	202.4±7.4*	20.158	217.2±8.7*	17.257	206.3±7.9*	16.227	174.3±6.2*	34.350
4w	185.6 ± 5.9*	26.295	166.3±6.3*	34.398	157.9±5.4*	39.848	141.7±5.2*	28.515	86.1±2.3*	67.571

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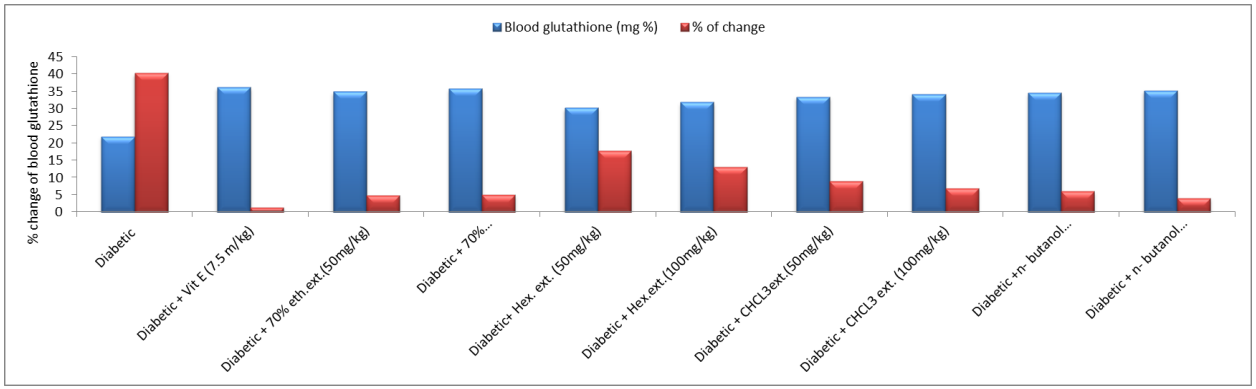

Figure 1: Antioxidant activity of *L. decipiens*

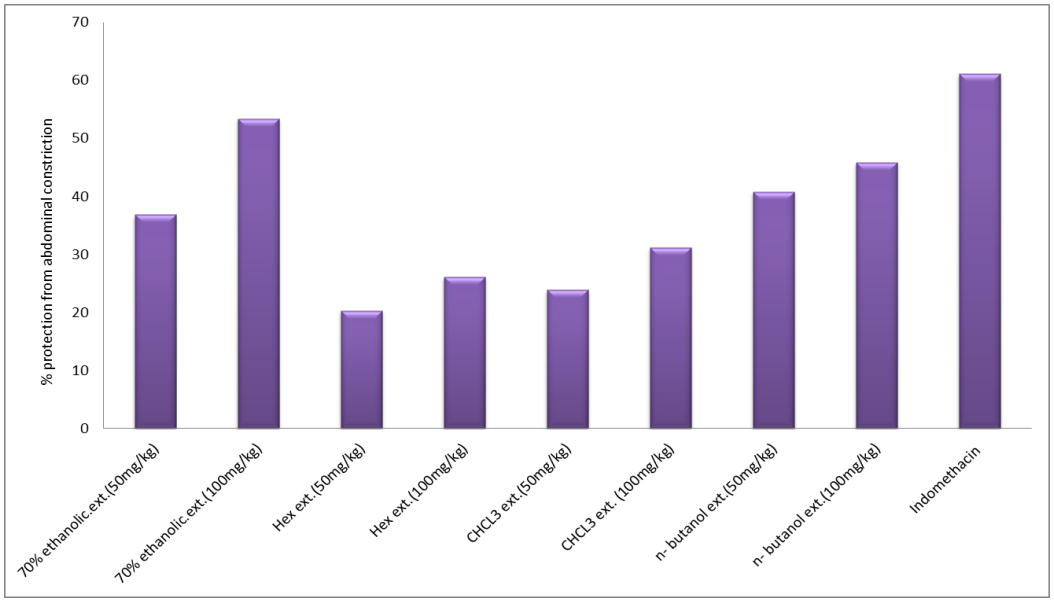

Figure 2: Analgesic activity of *L. decipiens*

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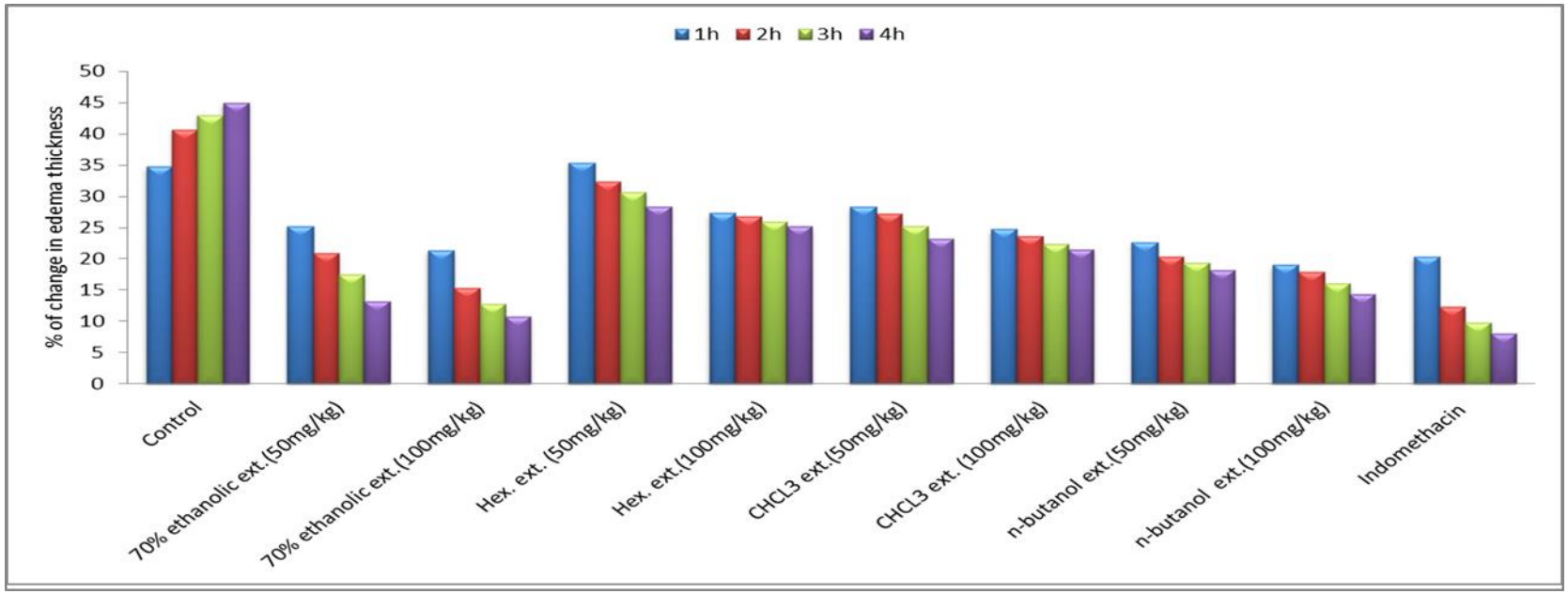

Figure 3: Acute anti-inflammatory activity of *L. decipiens*

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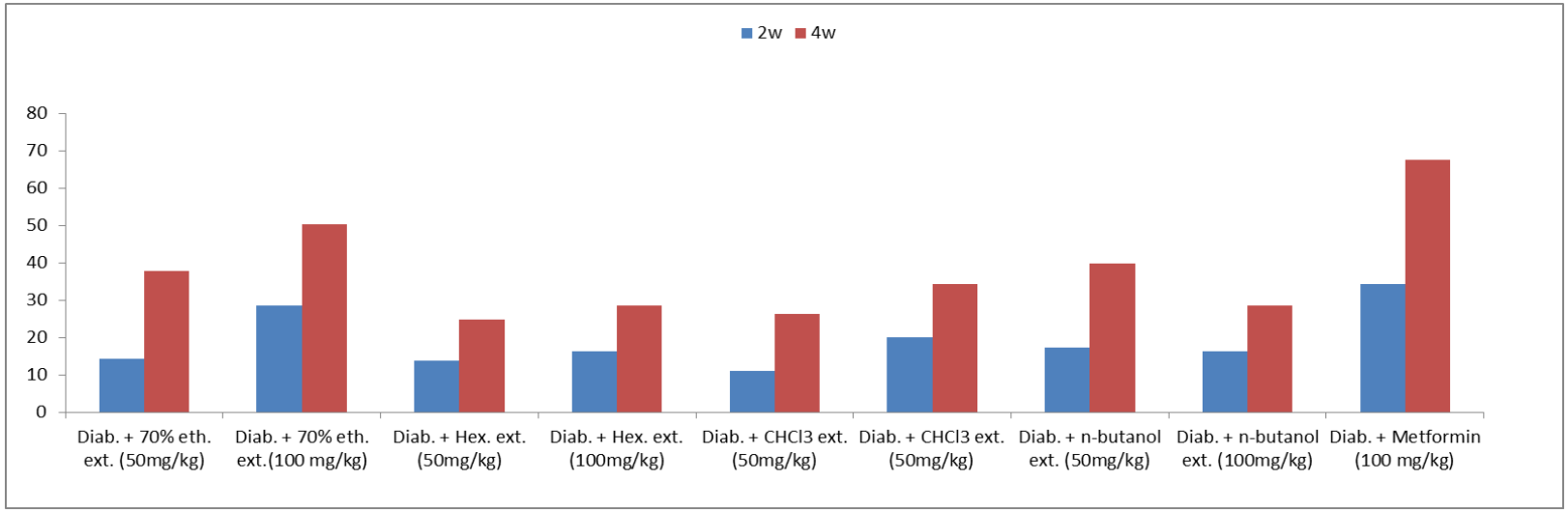

Figure 4: Antihyperglycemic activity of *L. decipiens*

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CONCLUSION

Livistona decipiens represents a new natural source for phenolic compounds. It is a promising, potent and effective medicinal plant as it exhibited potent antioxidant, analgesic, antihyperglycemic and anti-inflammatory activities. Our study tends to support the therapeutic value of this plant as antioxidant, analgesic, antihyperglycemic and anti-inflammatory drugs.

Conflicts of interest

The authors declare that there is no conflict of interest.

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