Advanced research on promissory edible plants in Latin America: tools to improve Food Security in the region

The Importance of Cashew Nut Shell Liquid from *Anacardium occidentalis*

Maria Teresa Salles Trevisan

Ceará Federal University – Brazil

Functional Food

2/2005

dkfz. GERMAN CANCER RESEARCH CENTER IN THE HELMHOLTZ ASSOCIATION

alumni

DEUTSCHES KREBSFORSCHUNGSZENTRUM

cooperation

Antioxidant Components in Brazilian Fruits and Plants

by Maria Teresa Salles Trevisan

Maria Teresa Salles Trevisan (third on left) graduated from São Carlos Federal University in Brazil in 1986, obtained her Master Science in 1989. She worked as a Visiting Scientist in Alagoas Federal University from 1989 to 1992. Her PhD was in Plant Biotechnology, obtained in 1997 at Leiden University, The Netherlands. She began to work as a lecturer at Ceará Federal University in 1998, where she conducts research and supervises students in the post-graduation course in Organic Chemistry.

- 2009

Exchange secures partnerships

The German Academic Exchange Service (DAAD) promotes international mobility through scholarships for students and scientists as well as through partnerships between German and foreign institutions of higher education.

The continuing education and training of foreign higher education graduates and former scholarship holders in current topics of development cooperation, has been a part of the DAAD program for many years.

High-quality education and continuing education and training of experts are fundamental for the progress in developing countries and for the realization of the Millennium Development Goals. The DAAD supports the networking of experts and key personal in the areas of politics, economy, and culture through the construction and expansion of regional and expert alumni networks. At the same time, the DAAD offers the alumni a wide spectrum of continuing education programs.

Experts from developing countries, who studied at German higher education institutions, are in addition to their knowledge of the German language and culture, familiar with the German work mentality. In their home countries, they are often holding high-ranking positions, and are competent contact persons for members of science and economy on a local level.

FORUM

Ernährungssicherung im Brennpunkt

Focus on Food Security

DAAD Deutscher Akademischer Austausch Dienst
German Academic Exchange Service

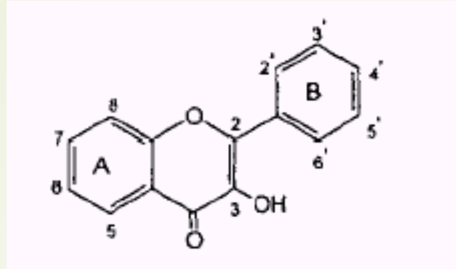
Dr. Maria Teresa Salles Trevisan

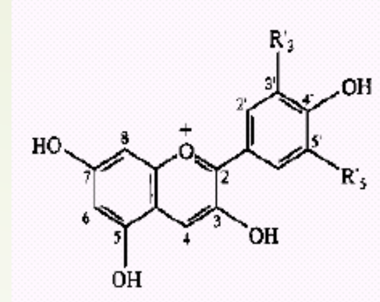
BRAZIL

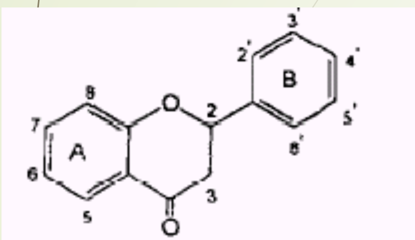
PhD at Universiteit Leiden, Netherlands.

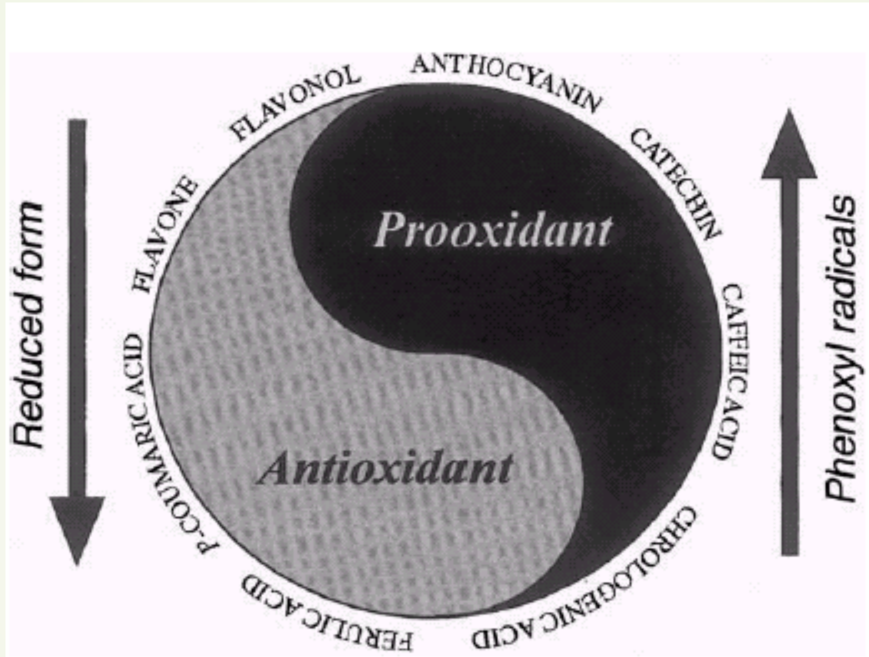
Post-Doctoral Research Position at the German Cancer Research Center (DKFZ) in Heidelberg.

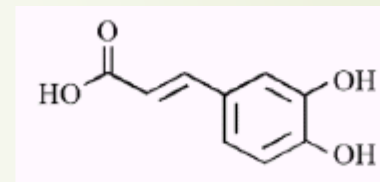
Assistant Professor at the Universidade Federal do Ceará, Department of Organic and Inorganic Chemistry.

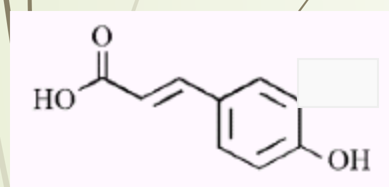


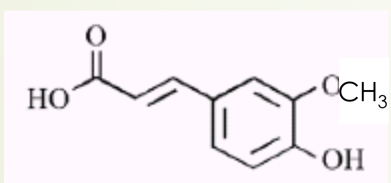


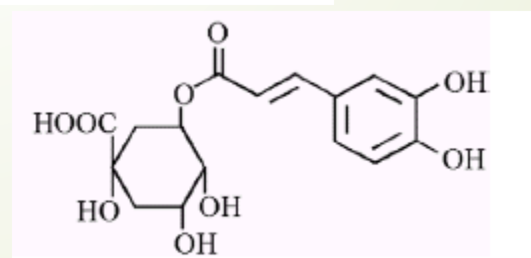






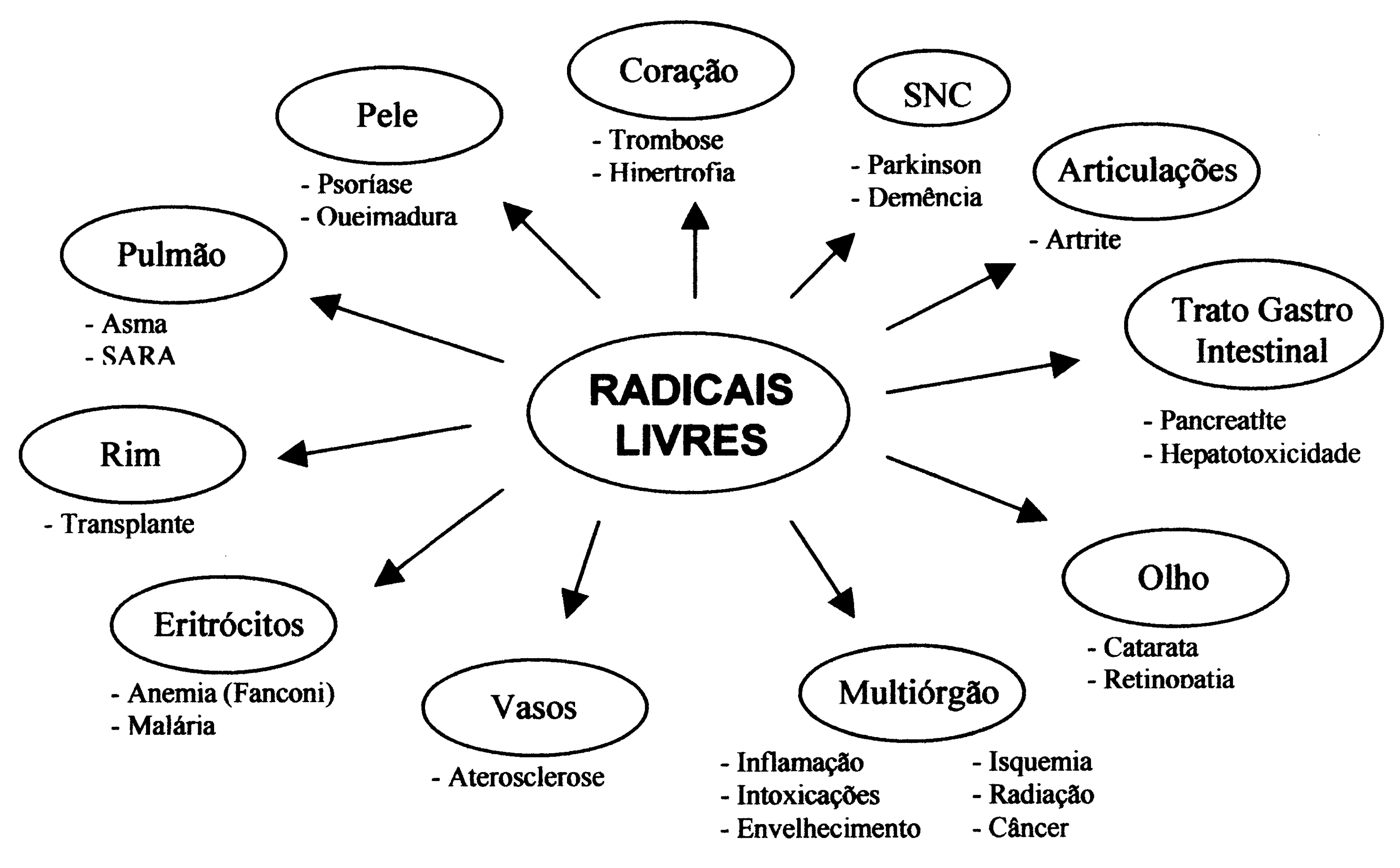






Toxicology 177 (2002) 67–80

Oxidative Stress and Antioxidants



Chemoprevention

- Process of inhibiting, delaying or reversing carcinogenesis in the premalignant phase through use of non-cytotoxic nutrients and/or pharmacological agents
- A wide arrays of phenolic substances, particularly those present in dietary and medicinal plants, have been reported to possess substancial anticarcinogenic and antimutagenic activities
- The marjority of these naturally occurring phenolics retain antioxidative properties which appear to contribute to their chemopreventive and chemoprotective activity
- Synthetic antioxidants such as butylated hydroxytoluene (BHT) and butylated hydroxyanisole (BHA), used to retard lipid oxidation in foodstuffs possess carcinogenic activity

BIOECONOMY CONCEPT

Set of economic activities based on the **use of renewable biological resources (biomass) in place of fossil raw materials** for the production of food, feed, materials, chemicals, fuels and energy for the **production and promotion of health, sustainable development, growth and well-being for society.**

Bruno Nunes
CGBE/SEPED/MCTIC

Action Plan of Science, Technology and Innovation in Bioeconomy

Biomass

- Inputs
- Integrated production systems
- Waste streams
- Biodiversity sustainable uses
- Genetic improvement

Process

- Pretreatment and treatment technologies
- Bioremediation
- Technologies and inputs for planning, constructions and managing of bioindustries

Bioproducts

- Renewable chemistry
- Enzymes
- Biomaterials
- New compounds and its uses

Technological Convergence / Synthetic Biology / Industrial Biotechnology
Brazilian Bioeconomy Observatory / New Business Models / Human Resources / Funding

Transversal Issues

Bruno Nunes
CGBE/SEPED/MCTIC

MINISTÉRIO DA CIÊNCIA, TECNOLOGIA, INOVAÇÕES E COMUNICAÇÕES

BRASIL GOVERNO FEDERAL

Cashew(*Anacardium occidentale* L.)

by PatriciaMoura

- important cash crops of the northeastern region of Brazil
- 700,000 ha
- 100,000 people
- 200 million dollars
- exported USA, Europe, Japan
- cashew apples: juice, jam, alcoholic and soft drinks

Anacardium occidentale L.

- Cashew apple (juice, wine, cajuina)
- Fiber
- Nuts
- Cashew Nuts Shell Liquid (CNSL)
- Cashew Nuts Oil

by PatriciaMoura

EMBRAPA - Dra Débora Garrutti
CIONE - Jaime Thomas de Aquino

- CNSL
- Reduce the use of fossil fuel
- Source of unsaturated phenol (monomer for the polymer industry)
- Resins, adhesives
- Insecticidal products
- Anticorrosion paints
- Heating to 200 °C
- Anacardic acid start material - Nifedipine analogs (Ca Channel Blocking Activity)

- Patents
- Cashew nut shell composition
- Active oxygen inhibitors for cosmetics (CNS oil)
- Antioxidant for food and cosmetics

Antitumor activity

J. Agr. Food Chem. 41 (6): 1012, 1993

Carcinogenesis, Mutagenesis

Cancer Letter 112: 11-16, 1997

Cytotoxic Potential

Toxicology 177: 167-177, 2002


ALIMENTO À BASE DE
FIBRAS DE CAJÚ
IONE

Alkyl phenol	g/kg			
	CNSL	Fibre	Nut	Apple
Anacardic acid-1	153.50	1.81	(0.58),(0.35)•	0.22
Anacardic acid-2	107.96	1.81	(0.20),(0.12)•	0.32
Anacardic acid-3	92.12	2.49	(0.28),(0.18)•	0.56
Cardanol-1	97.61	n.d.	n.d.	n.d.
Cardanol-2	65.37	n.d.	n.d.	n.d.
Cardanol-3	55.31	n.d.	n.d.	n.d.
Cardol-1	98.18	n.d.	(0.22),(0.11)•	n.d.
Cardol-2	46.65	n.d	(0.07),(0.05)•	n.d.
Total	716.70	6.10	(1.06),(0.64)•	1.10

	IC_{50} (mM)	
Alkyl phenol	DHBA (4 $mM_{inh\%}$)	Xanthine oxidase (4 $mM_{inh\%}$)
Anacardic acid-1	0.27 (100)	0.19 (100)
Anacardic acid-2	0.56 (95)	0.38 (100)
Anacardic acid-3	0.77 (93)	0.36 (99)
Cardanol-1	> 4.0 (0)	> 4.0 (0)
Cardol-1	1.71 (83)	0.97 (95)

Characterization of alkyl phenols in cashew (*Anacardium occidentale*) products and assay of their antioxidant capacity. **Food and Chemical Toxicology**

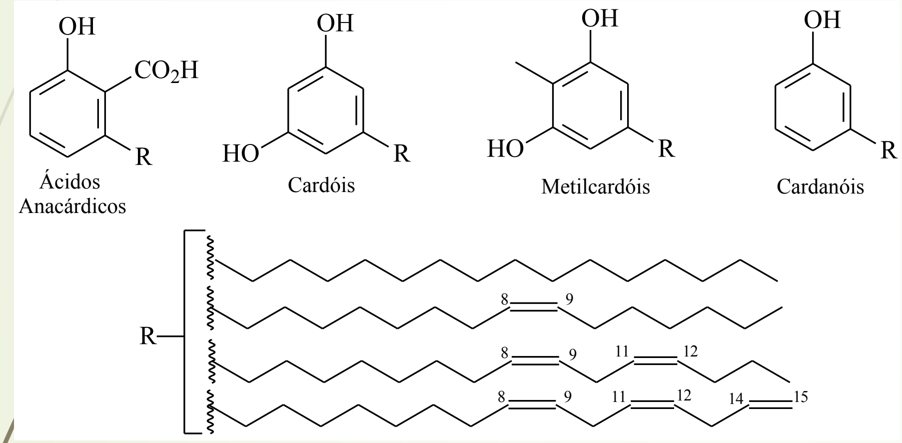
Cashew phenotype oil	Anacardic acid-1	Anacardic acid-2	Anacardic acid-3	Total
Commercial	69	29	37	135
BRS-226	72	18	34	124
BRS-275	725	208	309	1242
BRS-265	307	160	131	598
CCP-76	44	23	31	98
Embrapa-51	550	137	186	873
CCP-09	106	26	49	181
BRS-274	119	58	82	259

ApexBio Technology Product List

02 Feb 2015

2- hydroxy- 6- pentadecylbenzoic acid

Pricing: Quantity : 10 mg, Price: $ 85



Indofine Product List

19 Feb 2008

6-[8(Z),11(Z),14-Pentadcatrienyl] salicylic acid

Pricing: Quantity : 5 mg, Price: $390

Protective effect of anacardic acids from cashew (*Anacardium occidentale*) on ethanol-induced gastric damage in mice

The effect of anacardic acids on gastric damage induced by absolute ethanol in mice.

Treatment	Dose	Ethanol lesion area (mm^2)
Control (vehicle)	–	20.49 ± 2.28
Anacardic acids	10 mg/kg, p.o.	15.30 ± 0.93* (25.3%)
	30 mg/kg, p.o.	7.46 ± 0.86* (63.6%)
	100 mg/kg, p.o.	3.52 ± 0.46* (82.8%)
Misoprostol	50 µg/kg, p.o.	7.62 ± 0.56* (62.8%)

The results are mean ± SEM for 8 animals/group. Statistical comparison was performed using ANOVA followed by the Student Newman–Keul's multiple test.

* $p < 0.05$ compared with the control (vehicle) group.

Effect of anacardic acids on the levels of superoxide dismutase (SOD), catalase, lipid peroxidation (MDA) and nitrate/nitrite in glandular stomach of mice treated with absolute ethanol.

Treatment	Dose	MDA (nmol/g tissue)	Catalase (mmol/min/g tissue)	SOD (U/g protein)	Nitrate/Nitrite (µM/g protein)
Control (normal)	–	3.633 ± 0.094	1.617 ± 0.163	517.5 ± 31.44	722.20 ± 117.20
Control (vehicle)	–	4.349 ± 0.149[a]	0.968 ± 0.058[a]	332.9 ± 42.86[a]	285.20 ± 35.37[a]
Anacardic acids	30 mg/kg, p.o.	3.734 ± 0.084[b]	2.006 ± 0.258[b]	731.3 ± 75.79[b]	548.40 ± 76.05[b]
N-acetylcysteine	750 mg/kg, p.o.	3.764 ± 0.185[b]	2.263 ± 0.154[b]	748.6 ± 76.86[b]	583.80 ± 69.42[b]

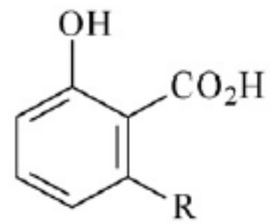
The results are mean ± SEM for 8 animals/group. Statistical comparison was performed using ANOVA followed by the Student Newman–Keul's multiple test.

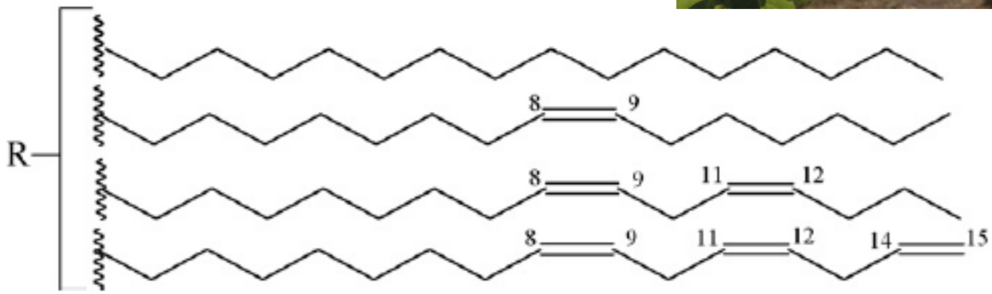
[a] $p < 0.05$ compared with the control (normal) group;

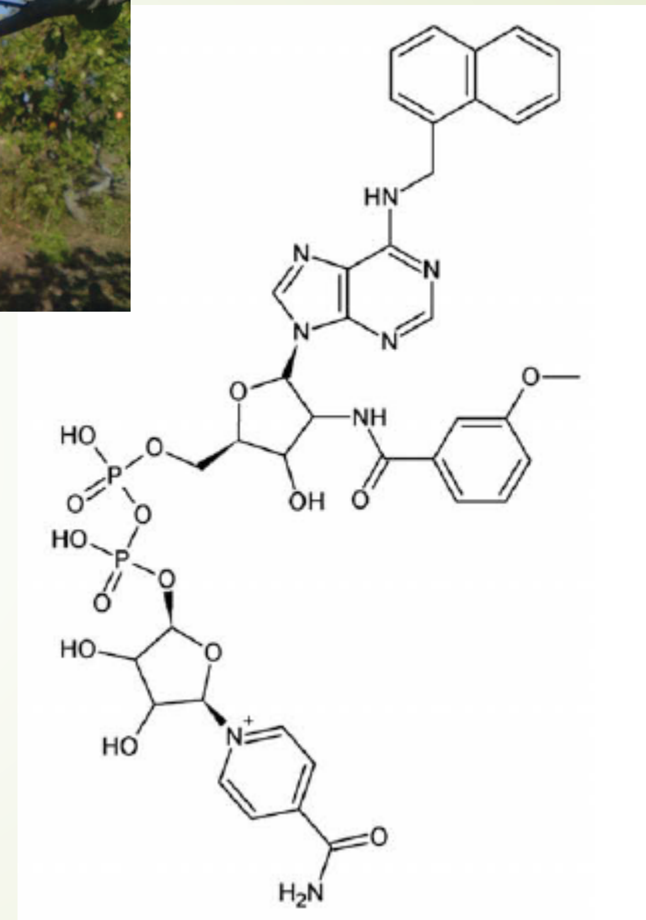
[b] $p < 0.05$ compared with the control (vehicle) group.

Chemico-Biological Interactions 183 (2010) 264–269

Discovery of novel *Trypanosoma cruzi* glyceraldehyde-3-phosphate dehydrogenase inhibitors







(9)

Inibição de GAPTH	IC 50 μM
8E, 11E, 14E – Ácido Anacárdico	38
8E, 11E – Ácido Anacárdico	69
8E – Ácido Anacárdico	161
Composto 9	0,10

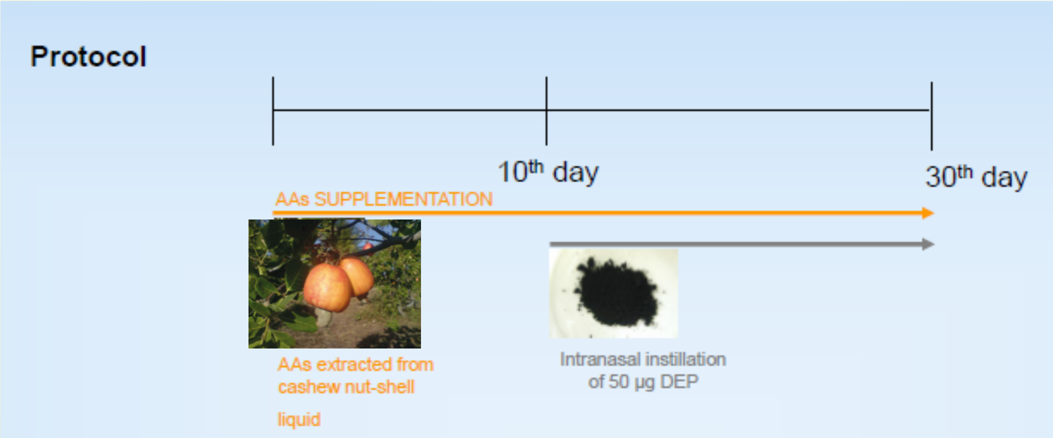
Acute, subacute toxicity and mutagenic effects of anacardic acids from cashew (*Anacardium occidentale* Linn.) in mice

Journal of Ethnopharmacology 135 (2011) 730–736

AAs	Dose (mg/Kg)	Tempo (dias)
Toxicidade Aguda	2000	14
Toxicidade Sub Aguda		
	300	30
	600	30
	1000	30

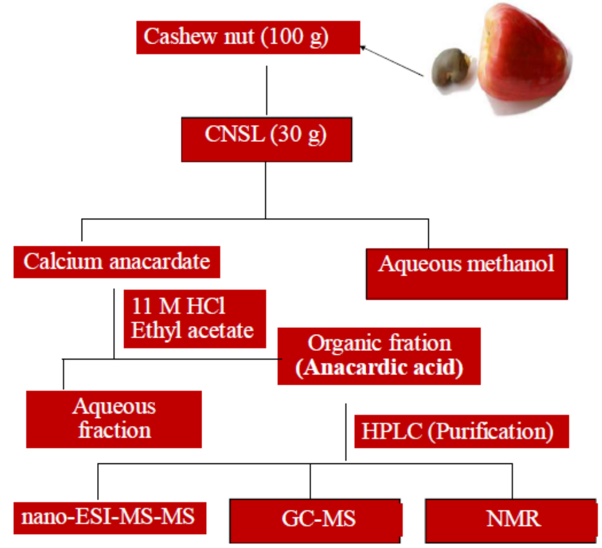
Anacardic Acids from Cashew Nuts Ameliorate Lung Damage Induced by *Exposure* to Diesel Exhaust Particles in Mice

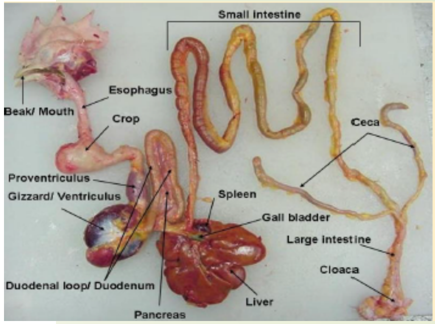
Evidence-Based Complementary and Alternative Medicine
Volume 2013, Article ID 549879, 13 pages




KUHL

IC e voluntários	Volumes				
1	941,06	763,02	813,89		
2	1017,36	991,93	890,19		
3	915,62	864,76	712,15	712,15	763,02
4	890,19	763,02	737,59	966,49	457,81
5	839,32	763,02	712,15		
6	508,68	839,32	763,02	941,06	686,72
7	1017,36	763,02			





Effect of anacardic acid on oxidative and color stability of spray dried egg yolk☆

LWT - Food Science and Technology 55 (2014) 466–471

Figure 1. Powdered egg.

Table 1. Treatment and total carotenoid (%)

Treatment	Total Carotenoid (%)
Control SD	100,00
SD + BHT	104,25
SD + 50 mg/kg	108,73
SD + 100 mg/kg	114,14
SD + 150 mg/kg	124,77
SD + 200 mg/kg	107,36
Control FD	124,62
FD + 200 mg/kg	118,89

	Carotenoids %	Vitamin E %	Total AA %
T1	100	100	
T2	100	65	
T3	116	106	56
T4	102	81	82
T5	91	67	100
T6	109	82	95

Addition of anacardic acid as antioxidants in broiler chicken mortadella

Food Sci. Technol, Campinas, 35(3): 539-545, Jul.-Set. 2015

Table 1. Formulation of chicken mortadellas containing synthetic antioxidant (butylated hydroxytoluene) or anacardic acid (AA).

Meat componentes	%
Thigh and drumsticks	85.00
Back fat	15.00
Ingredients and additives	% of meat
Iced-water	10.00
Starch	5.00
Sodium chloride	1.10
Mortadella condiment [1]	1.00
Cured salt [2]	0.30
Garlic	0.30
Antioxidant [3]	BHT or AA
Sodium tripolyphosphate	0.25
Spices	0.15

[1]Refined sodium chloride and natural flavoring. [2]Refined sodium chloride, sodium nitrite (INS 250) and sodium nitrate (INS 251). [3]Not added in the samples of control treatment.

The results of this study suggest that anacardic acid, in the dose of 200 ppm, is a potential natural antioxidant for addition to chicken mortadellas stored for up to 90 days at 4 °C.

Table 2. Thiobarbituric acid-reactive substances values (mg MDA.kg^{-1} sample) of mortadellas added of butylated hydroxytoluene (BHT) or anacardic acid (AA) and stored at 4 °C for 90 days.

Treatments	Storage time (days)				
	0	30	60	90	Mean
without antioxidant	0.38±0.01	0.35±0.01	0.33±0.04	0.31±0.02	0.34±0.03a
100 ppm BHT	0.27±0.02	0.31±0.03	0.31±0.03	0.31±0.08	0.30±0.02b
50 ppm AA	0.31±0.01	0.33±0.03	0.30±0.02	0.32±0.11	0.2±0.01ab
100 ppm AA	0.29±0.08	0.28±0.01	0.30±0.04	0.28±0.02	0.29±0.01bc
150 ppm AA	0.25±0.03	0.25±0.03	0.25±0.01	0.30±0.01	0.26±0.02c
200 ppm AA	0.17±0.07	0.18±0.05	0.20 ±0.02	0.20±0.04	0.19±0.02d
Mean	0.28±0.07	0.28±0.06	0.28±0.05	0.29±0.04	
ANOVA effects	p-Value				
Treatment	<0.0001				
Time	0.8426				
Treatment x time	0.2179				
CV (%)	15.15				

n=5; Means with different letters in the columns differ by the Student-Newman-Keuls test (p <0.05); ANOVA = Analysis of variance; CV = Coefficient of variation.

CASHEW NUT SHELL LIQUID SUPPLEMENTATION AND THE EFFECT ON LIPID OXIDATION AND COLOR IN FRESH AND SPRAY-DRIED EGGS

Journal of Food Processing and Preservation ISSN 1745-4549

TABLE 1. COMPOSITION OF EXPERIMENTAL DIETS CONTAINING CASHEW NUT SHELL LIQUID

	Cashew nut shell liquid levels (%)				
Ingredients (g/kg)	0.00	0.25	0.50	0.75	1.00
Corn	61.40	61.40	61.40	61.40	61.40
Soybean meal	26.15	26.15	26.15	26.15	26.15
Soybean oil	0.31	0.31	0.31	0.31	0.31
Limestone	8.79	8.79	8.79	8.79	8.79
Dicalcium phosphate	1.70	1.70	1.70	1.70	1.70
Methionine	0.13	0.13	0.13	0.13	0.13
Vitamin for laying*	0.05	0.05	0.05	0.05	0.05
Mineral for laying†	0.10	0.10	0.10	0.10	0.10
Salt	0.37	0.37	0.37	0.37	0.37
Inert (sand washed)	1.00	0.75	0.50	0.25	0.00
Antioxidant‡	0.00	0.00	0.00	0.00	0.00
Cashew nut shell liquid	0.00	0.25	0.50	0.75	1.00
Total	100.00	100.00	100.00	100.00	100.00
	Calculated composition				
Metabolizable energy (kcal/kg)	2.700	2.700	2.700	2.700	2.700
Crude protein (%)	17.00	17.00	17.00	17.00	17.00
Neutral detergente fiber (%)	10.84	10.84	10.84	10.84	10.84
Acid detergente fiber (%)	4.31	4.31	4.31	4.31	4.31
Linoleic acid (%)	1.53	1.53	1.53	1.53	1.53
Calcium (%)	3.90	3.90	3.90	3.90	3.90
Avaliable phosphorus (%)	0.41	0.41	0.41	0.41	0.41
Total phosphorus (%)	0.62	0.62	0.62	0.62	0.62
Sodium (%)	0.18	0.18	0.18	0.18	0.18
Total lysine (%)	0.87	0.87	0.87	0.87	0.87
Total methionine (%)	0.40	0.40	0.40	0.40	0.40
Total methionine + cystine (%)	0.68	0.68	0.68	0.68	0.68
Total threonine (%)	0.66	0.66	0.66	0.66	0.66
Total tryptophan (%)	0.21	0.21	0.21	0.21	0.21

* Vitamin (amount provided per kilogram): vitamin A – 20.000.000 UI/kg; vitamin D3 – 7.000.000 UI/kg; vitamin E – 80.000 mg/kg; vitamin K3 (menadione) – 4.000 mg/kg; vitamin B1 – 3.000 mg/kg; vitamin B2 – 10.000 mg/kg; vitamin B6 – 6.000 mg/kg; vitamin B12 – 20.000 mcg/kg; vitamin C – 300 mg/kg; niacin – 60.000 mg/kg; pantothenic acid – 20.000 mg/kg; biotin – 50 mg/kg; folic acid – 1.000 mg/kg; selenium – 600 mg/kg.

† Minerals (amount provided per kilogram): iron – 50.000 mg/kg; cobalt – 200 mg/kg; copper – 10.000 mg/kg; zinc – 60.000 mg/kg; inorganic manganese – 80.000 mg/kg; iodine – 1.000 mg/kg.

‡ Banox: butylated hidroxyanisole, butylated hidroxytoluene, Propylgallate.

The cashew nut shell liquid is a potential natural antioxidant for fresh and spray-dried yolk eggs submitted to storage when added in the laying diet.

The increase of cashew nut shell liquid concentration promoted the lowest TBARS values during storage of the fresh and spray-dried yolks. The cashew nut shell liquid inclusion provided higher yellowness in the yolks.

The concentration of 0.50% cashew nut shell liquid had the best results among treatments studied to prevent the damage of lipid oxidation in the fresh yolk, favoring the coloring of fresh yolks during refrigerated storage for 60 days. For spray-dried yolks, the best results was with 0.75% cashew nut shell liquid during storage for 180 days.

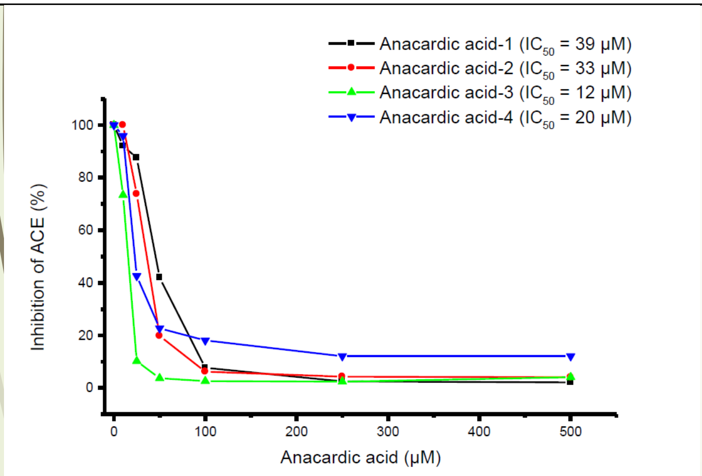
Serum biochemical profile, enzymatic activity and lipid peroxidation in organs of laying hens fed diets containing cashew nut shell liquid

Journal of Animal Physiology and Animal Nutrition

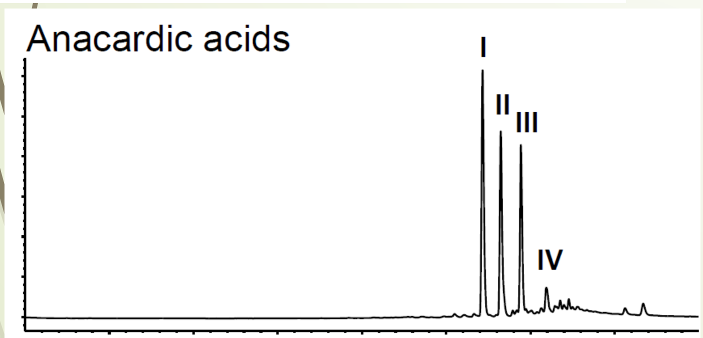
Based on the results of the current research, it can be concluded that addition of up to 1% of CNSL as a source of anacardic acid to laying hen diets does not affect the blood biochemical parameters or the activity of the SOD enzyme and NP-SH in the liver, ovary, magnum and uterus. In addition, except for the ovary, the inclusion of CNSL in laying hens diets influences the lipid peroxidation, but the problem is reduced from the inclusion of 0.75% CNSL.

Alkyl phenols	IC_{50} (µM)
CNSL	50
Anacardic acids	18
Cardanols	> 500
Cardols	> 500
Anacardic acid-1	39
Anacardic acid-2	33
Anacardic acid-3	12
Anacardic acid-4	20
Captopril (postive control)	**6.85 nM**

Other phenolic compounds	
Pentagallate	504
Ellagic acid	969
Mangiferin	
Maclurin	
Luteolin	
Taxifolin	negative
Salicylic acid	negative



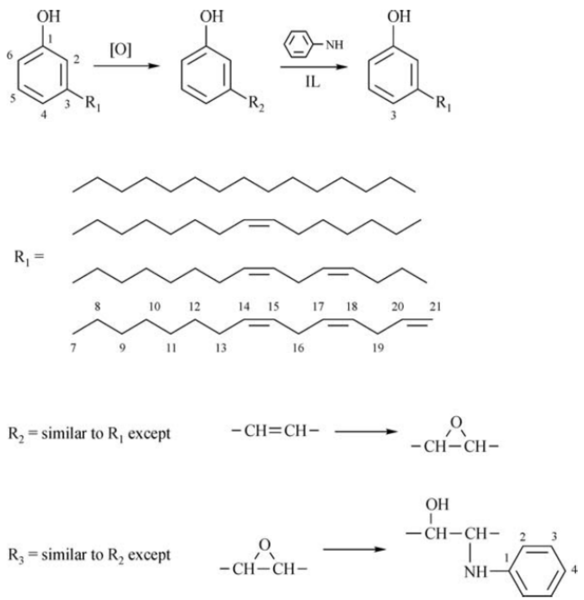
Published values	
(-)-Epicatechin	1783
(+)-Catechin	1593
Procyanidin dimer	267
Procyanidin trimer	126
Procyanidin tetramer	12
Procyanidin pentamer	25
Procyanidin hexamer	10



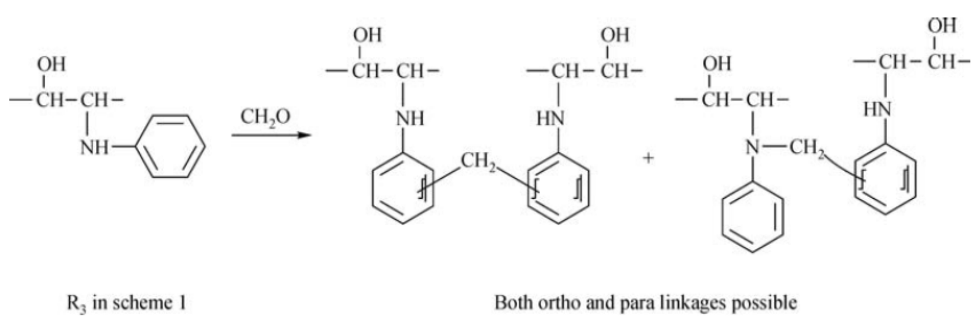
Inhibition of angiotensin I converting enzyme (ACE) by anacardic acids isolated from Cashew (*Anacardium occidentale* Linn.) nut shell liquid.
In: 6th General Alumni Meeting, 2014, Heidelberg.
6th General Alumni Meeting, 2014

Synthesis of a cardanol-amine derivative using an ionic liquid catalyst

Front. Chem. Sci. Eng. 2016, 10(3): 425–431
DOI 10.1007/s11705-016-1581-3



Scheme 1 Formation of cardanol epoxide (reaction 1) and amination (reaction 2) in the presence of an ionic liquid (IL)



Scheme 2 Formation of cardanol-containing aniline-formaldehyde resin

NEW METHODOLOGY FOR RAPID FORMATION/COMBAT OF ADVANCED GLYCATION END PRODUCTS (AGES) COUPLED WITH THE HYPOXANTHINE/XANTHINENOXIDASE ASSAY SYSTEM

Samuel Pedro Dantas Marques (UFC), Maria Teresa Salles Trevisan (UFC), Robert Wyn Owen (DKFz), Andrea Breuer (DKFz)

46th World Chemistry Congress, July 7 to 13, 2017 - São Paulo - Brazil

-Figure 1. Chemical structure of some AGEs and RCS already known in the current literature.

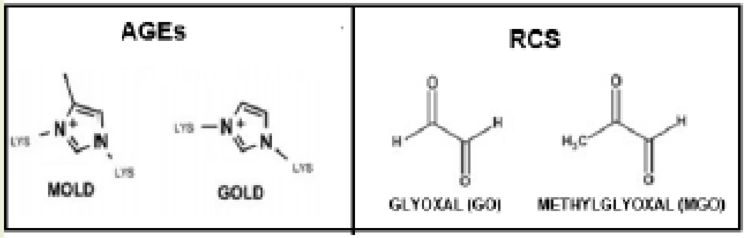


Figure 2. Schematic representation for the formation of AGEs coupled with the hypoxanthine/xanthinenoxidase assay system

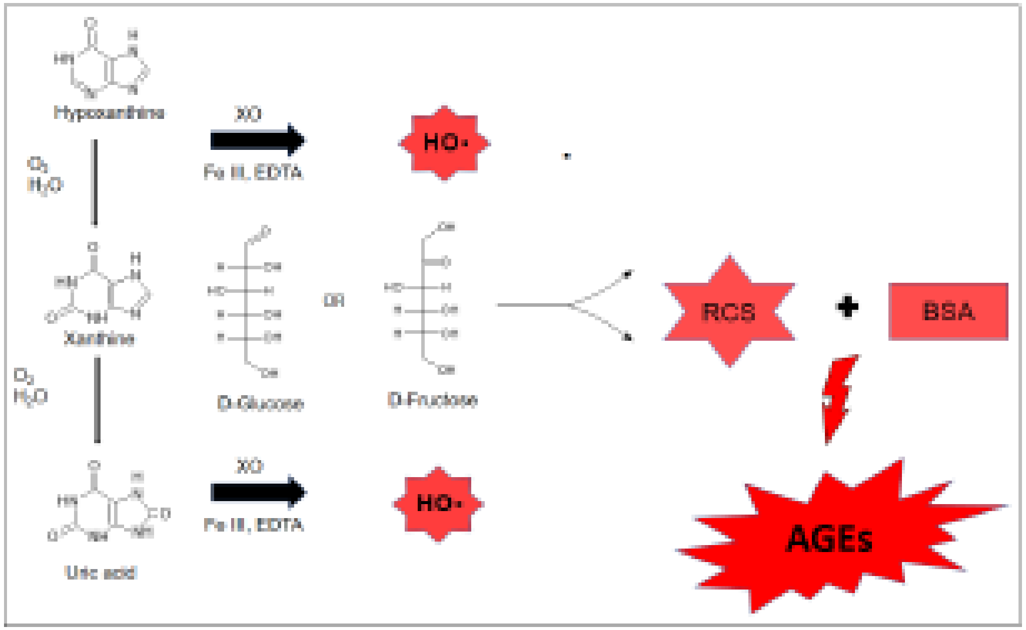
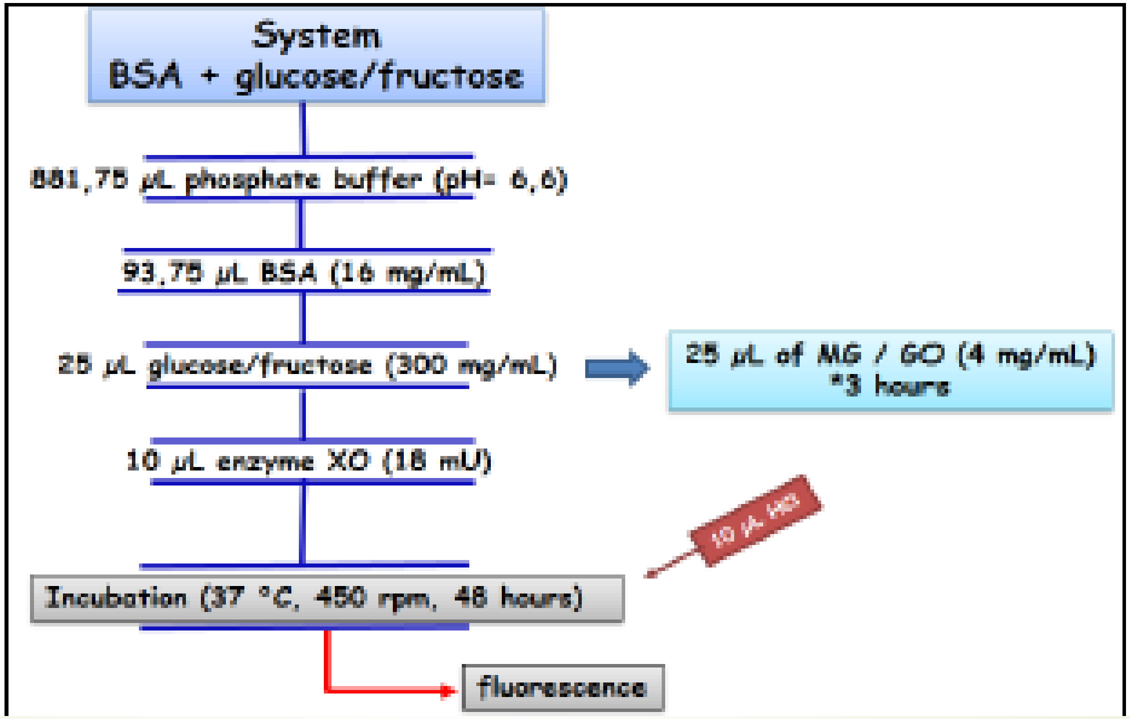
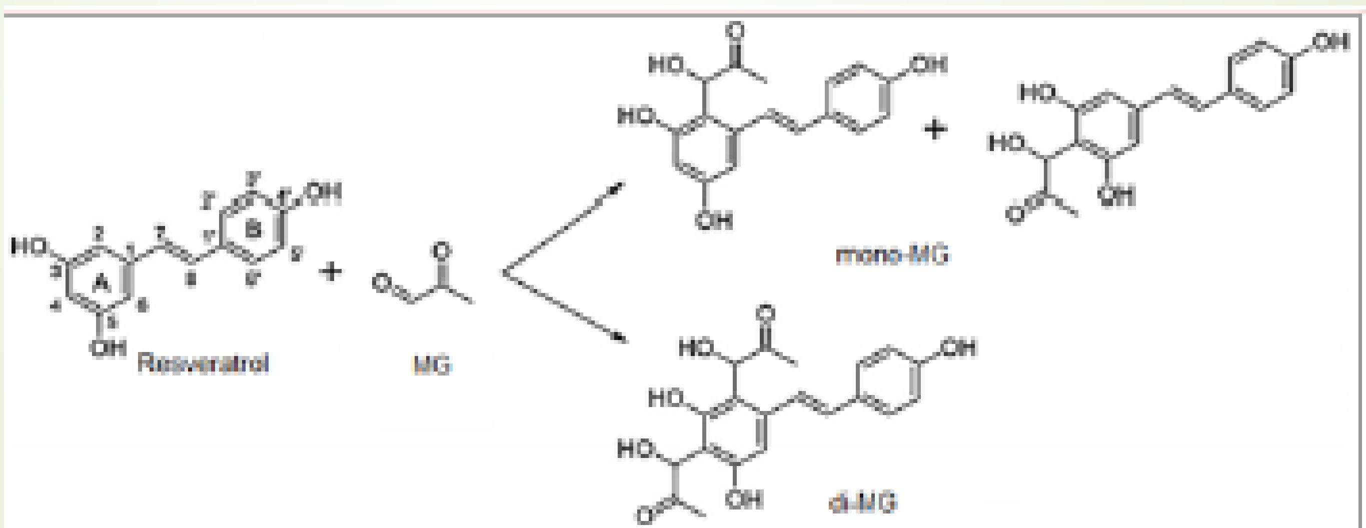


Figure 3. Flowchart for the development methods developed AGEs





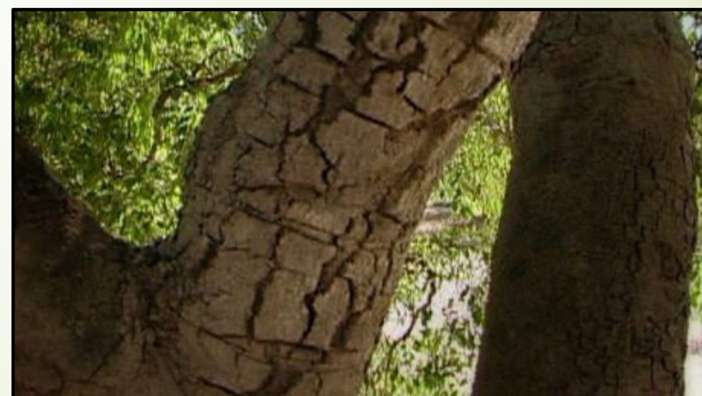
- *Hancornia Speciosa Gomes*

Fruit

Hancornia Speciosa Gomes

Látex

Leaves

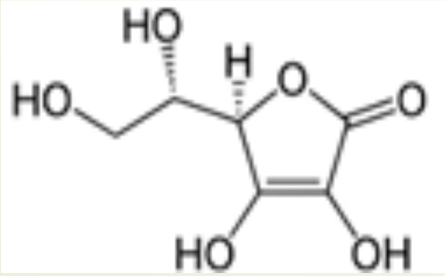


Bark

- *Hancornia Speciosa Gomes*

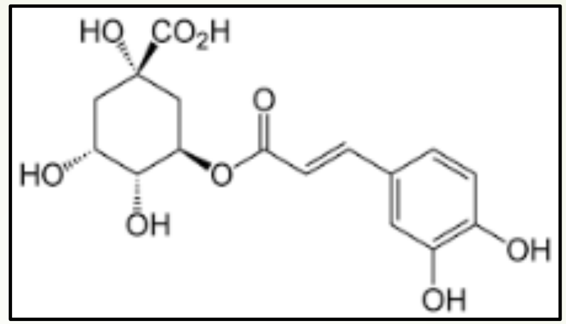
Fruit *(Mangaba)*

Vitamin C
139 mg/100g

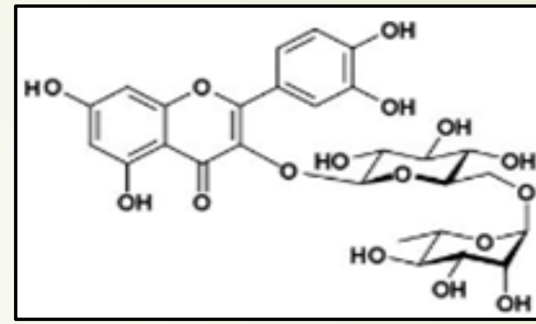


- *Hancornia Speciosa Gomes*

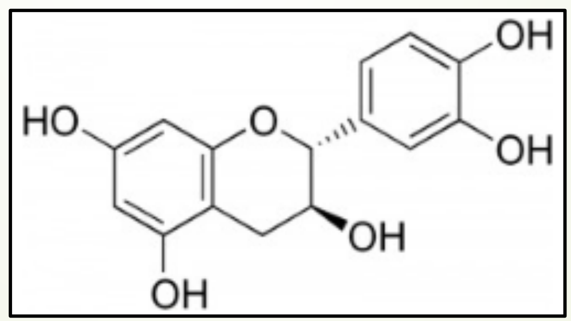
Fruit (Mangaba)



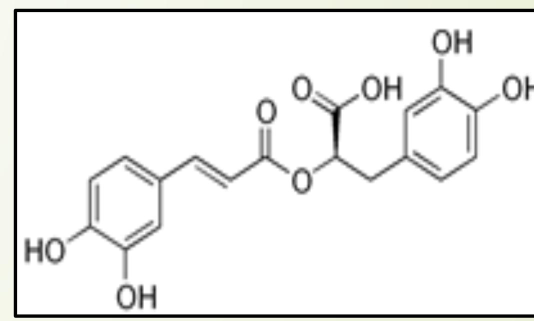
Chlorogenic acid



Rutin

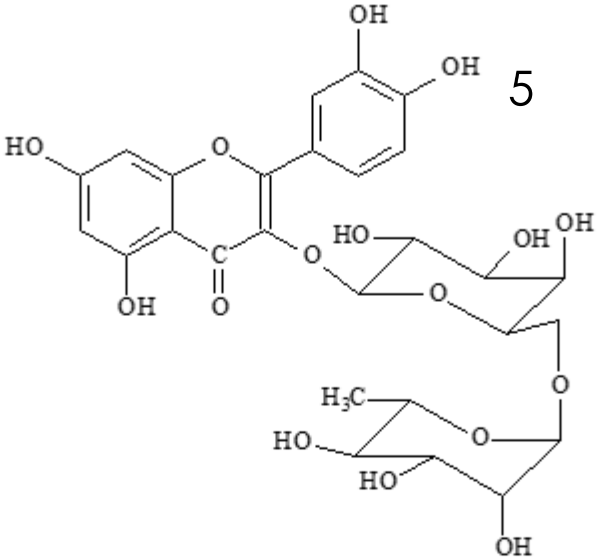


Catequin

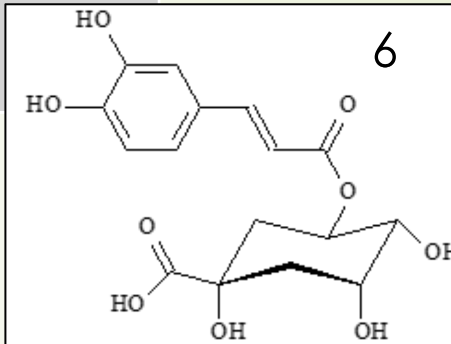


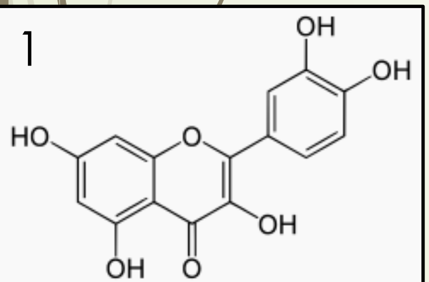
Rosmaric acid

- Fruit

5

Quercetina-3-O-ramnogalactosídeo
$C_{27}H_{30}O_{16}$

FRUIT
1) Quercetin 2) Rutin 3) Vanillin 4) *Trans*-ferulic acid 5) Quercetin 3-O-ramnogalactosideo 6) Chlorogenic acid

6

Ácido clorogênico
$C_{16}H_{18}O_9$

1


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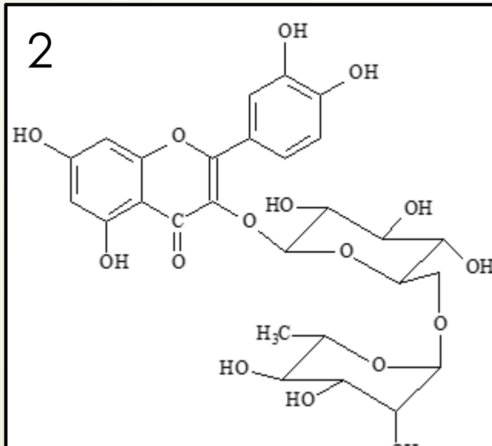

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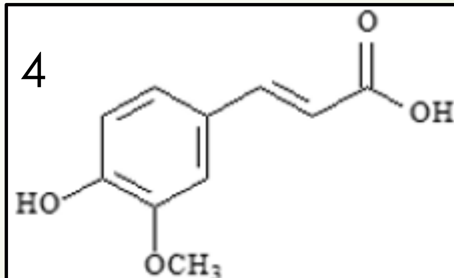

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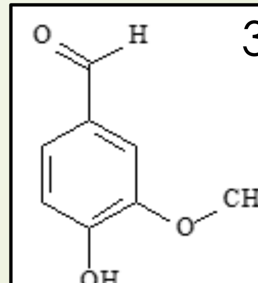

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Research Article
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Antioxidant Capacity, Angiotensin I Converting Enzyme (ACE) and Acetylcholinesterase Inhibition by Extracts of the Leaves and Bark of *Hancornia speciosa* Gomes

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HUMAN

Samuel Pedro Dantas Marques [a], Irvila Ricarte de Oliveira [*a], Robert Wyn Owen [*b], Maria Teresa Salles Trevisan [a]

(a) Universidade Federal do Ceará. Departamento de Pós-Graduação em Química, Campus do Pici – Bloco 940 – Cx. Postal: 6021, CEP: 60455-760, Fortaleza- CE – Brasil.

(b) National Center for Tumor Diseases (NCT) / German Cancer Research Center (DKFZ), Division of Preventive Oncology, Im Neuenheimer Feld 460, 69120 Heidelberg, Germany.

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ABSTRACT

Purpose: To determine the antioxidant capacity, angiotensin I converting enzyme, and acetylcholinesterase inhibition, by extracts of the leaves and bark of *Hancornia speciosa* Gomes (*H. speciosa*). **Methods:** Antioxidant capacity of methanol extracts of *H. speciosa* was evaluated *in vitro* by the DPPH, FRAP, ORAC and the HPLC-based HX/XO assays. The antihypertension capacities of methanol extracts from *Hancornia speciosa* extracts were evaluated *in vitro*, by their ability to inhibit angiotensin I converting enzyme using analytical reverse-phase high performance liquid chromatography. In addition, thin-layer chromatography was used to screen. **Results:** The methanol extracts (10.0 mg/mL) from the leaves and bark of *H. speciosa* were very effective in the inhibtion of ACE activity (97.63 % ± 2.89 % and 95.07 % ± 3.76 %, with significant IC_{50} values of 79.24 µg/mL and 146.47 µg/mL respectively). In the antioxidant assays, the extracts exhibited low antioxidant capacity in the FRAP and DPPH assays, but were effective in the ORAC assay (ORAC units = 2.70, and 1.74 respectively, compared to Trolox = 1.0). Only the methanol leaf extract exhibited discernable antioxidant capacity in the HPLC-based HX/XO (IC50 = 12.0 ug/uL) assay. Both the hexane and ethanol extracts of bark but only the ethanol extract of leaves inhibited acetylcholinesterase (AChE). The active principle, responsible for acetylcholinesterase inhibition, following purification by column chromatography, and identification by ^{1}H and ^{13}C NMR was determined as lupeol.

Ximenia americana

Bark

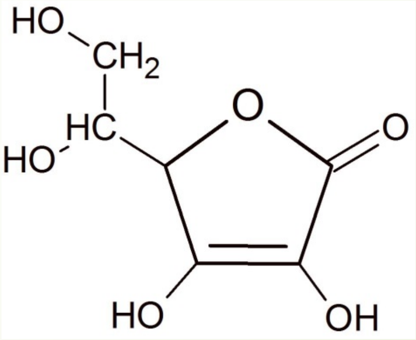
Leaves

Fruit

Seeds

FRUTO

❖ Good source of vitamin C



	DPPH	ABTS
	IC_{50} (mg/L)	EC (TEACg-1)
Leaves	258,50	179,55 ± (5,38)
Bark	123,56	387,75 ± (0,56)
Roots	93,97	436,33 ± (6,54)
BHT	289,17	
		350.8258± (7.18)

Ximenia americana leaves (5mg/mL)

Compound	Retention time (min)	Peak area
Gallic acid (278 nM)	6.16	273
Gallic acid quinate	7.51	185
Chlorogenic acid (320 nm)	20.58	184
Quercetin arabinoside-1	35.87	497
Quercetin arabinoside-1	36.41	348
Quercetin arabinoside-1	37.02	961
Quercetin rhamnoside	37.41	2556
Kaempferol arabinoside-1	38.16	234
Kaempferol arabinoside-1	38.56	215
Kaempferol arabinoside-1	39.19	392
Kaempferol rhamnoside	39.59	576

Ximenia americana bark (5mg/mL)

Compound	Retention time (min)	Peak area
Gallic acid	6.16	41
3,4-DHBA (257 nm)	11.32	41
Procyanidin B1	16.66	162
(+)-Catechin	18.63	301
Procyanidin B1	20.80	370
(-)-Epicatechin	22.99	237
Procyanidin C1	24.46	260
Procyanidin tetramer	25.39	154
Procyanidin pentamer	26.60	178

Ximenia americana roots (5mg/mL)

Compound	Retention time (min)	Peak area
Gallic acid	6.16	9
3,4-DHBA (257 nm)	11.35	39
Procyanidin B1	16.66	73
(+)-Catechin	18.64	159
Procyanidin B1	20.80	287
(-)-Epicatechin	22.99	195
Procyanidin C1	24.45	318
Procyanidin tetramer	25.38	253

UFC

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