Natural Products Chemistry & Research

Adumanya, Nat Prod Chem Res 2016, 5:1
DOI: 10.4172/2329-6836.1000246

Research Article OMICS International

Carotenoids, Phenolics, Hydroxycinnamic Acids and Tannin Composition of *Salacia senegalensis* (Lam) DC Leaves

Adumanya OCU*

Department of Science Laboratory Tech. Imo State Polytechnic, Umuagwo Imo State, Nigeria

Abstract

Salacia senegalensis leaves with established antimalarials activities were assayed (dry weight) for its carotenoids, phenolics, hydroxycinnamic acids and tannin composition using gas chromatography analysis. The results showed the presence of carotenoids, phenolic acids, hydroxycinnamic acids and tannic acids. Ten known carotenoids were detected, mainly lutein (6.4370100 mg/100 g), carotene (4.0964900 mg/100 g), viola-xanthin (3.3858800 mg/100 g), zeaxanthin (2.8979100 mg/100 g), asta-xanthin (1.3826700 mg/100 g), beta-cryptoxanthin (0.3527960 mg/100 g), neo-xanthin (0.3501600 mg/100 g), malvidin (0.3150850 mg/100 g), anthera-xanthin (0.0063927 mg/100 g) and lycopene (0.0010883 mg/100 g). The phenolic acid constituents found were ferulic acid (0.1370260 mg/100 g), vanillic acid (0.1168070 mg/100 g), ellagic acid (0.0049325 mg/100 g), piperic acid (0.0015819 mg/100 g), syringic acid (0.0005970 mg/100 g) and rosmarinio acid (0.0005967 mg/100 g). Hydroxycinnamic acids detected were caffeic acid (3.3525900 mg/100 g), p-coumaric acid (2.2189400 mg/100 g), o-coumaric acid (0.0042574 mg/100 g), coumarin (0.0027936 mg/100 g), cinnamic acid (0.0012745 mg/100 g), and sinapinic acid (0.0003049 mg/100 g). While tannic acid (162.86 mg/100 g) was, the only tannin found in the leaves of *Salacia senegalensis*.

Keywords: *Salacia senegalensis*; Carotenoid; Phenolic; Hydroxycinnamic; Dry weight

Introduction

Carotenoids are very popular family of terpenoids that have been widely accepted as safe chemicals for food supplementation and neutraceutical purposes due to their intense colouring abilities, role as precursors of vitamin A, and antioxidant activity in animals [1]. They act as photoprotective agents in a dose-dependent manner, and may reduce the risk of sunburns, photoallergy and even some types of skin cancer [1,2]. Epidemiologic studies indicate that an increased intake of carotenoids is associated with a decreased risk of many types of cancer including lung, breast and those affecting the gastrointestinal tract [3,4] a decreased risk of cardiovascular disease [4,5] less incidences of age-related macular degeneration and reduction in xeropthalmia in areas with low preformed vitamin A intake [4,5].

Natural β-carotene is the precursor of vitamin A and has preventive action against eye diseases and cancer. Carotenes enhance immune response, protect skin cells against UV radiations, lower the risk of cardiovascular diseases, age related vision disorders, asthma and reduce inflammation [4,6,7].

Lycopene, a non-provitamin A carotenoid and potent antioxidant, gives tomatoes their red colour and is effective at quenching the destructive singlet oxygen. Along with carotene and lutein, it protects against lung, breast, uterus and prostate cancers [4]. It produces significant reduction in blood pressure, serum lipids, and oxidative stress markers [8-10]. Xanthophyll's, like lutein and zeaxanthin function as protective antioxidants for the retinal part of human eye [4].

Phenolics are large family of plant secondary metabolites comprising many biologically active compounds. Depending on the number of phenol subunits, phenolics can be places into two basic groups – simple phenols and polyphenols [11]. The group of simple phenols includes the so-called "phenolic acids", including hydroxybenzoic and hydroxycinnamic acid derivatives. Phenolics protect plants against environmental and biological stress like higher energy radiation exposure, bacterial infection or fungal attacks [12], cold stress, hyperthermia [13] and oxidative stress [2]. They are also important for cell structure, signaling and pigmentation [13]. Some phenolic acids and flavonoids are allelochemicals [14].

The most representative cinnamic acid is acid, which occurs in fruit, vegetable and coffee, mainly as an ester with quinic and (chlorogenic- or 5-caffeoylquinic acid) [15,16]. Others include p-coumaric (4-hydroxycinnamic) and ferulic (4-hydroxy-3-methoxycinnamic) acids [17]. Hydroxycinnamic acid derivatives have a wide array of biological and pharmacological activities including antioxidative, antiviral and ant-listerial activities [18,19]. Their antioxidant properties can be expressed in several ways. For instance, 1, 5-dicaffeolquinic acid is an hepatoprotector when challenged by carbon tetrachloride, a mechanism that involves, among others, radical scavenging [16]. Chlorogenic acid is a powerful antioxidant, cholegogue and hypoglycemic agent [18,19].

Tannins (commonly referred to as tannic acid) are water-soluble polyphenols that are present in many plant foods. The designation of tannin includes compounds of two distinct chemical groups: hydrolysable tannins (polymers of ellagic acid, or of gallic and ellagic acids, with glucose) [16] and condensed tannins, which result from the condensation of monomers of flavan-3-o1 units [16,20]. Given their relationship to phenolic acids and flavonoids, their antioxidant properties are not a surprise: they exert their antioxidant activity by scavenging free radicals, chelating trace metals and by binding proteins with suppression of their enzymatic activity [16]. Recent works [16,21,22] have described the capacity of tannins to enhance glucose uptake and inhibit adipogenesis, thus being potential drugs for the treatment of non-insulin dependent diabetes mellitus. Flavan-3-ols are thought to interfere in the pathogenesis of cardiovascular disease via several mechanisms: antioxidative, anti-thrombogenic, and

***Corresponding author:** Adumanya OCU, Department of Science Laboratory Tech. Imo State Polytechnic, Umuagwo Imo State, Nigeria, Tel: +23408037730442; E-mail: adumso2@yahoo.com

Received November 23, 2016; **Accepted** December 08, 2016; **Published** December 13, 2016

Citation: Adumanya OCU (2016) Carotenoids, Phenolics, Hydroxycinnamic Acids and Tannin Composition of *Salacia senegalensis* (Lam) DC Leaves. Nat Prod Chem Res 5: 246. doi: 10.4172/2329-6836.1000246

anti-inflammatory. In particular, proanthocyanidins and flavan-3-o1 monomers lower plasma cholesterol levels, inhibit LDL oxidation, and activate endothelial nitric oxide synthase to prevent platelet adhesion and aggregation that contribute to blood clot formation [16,23,24]. Tannins also exert other physiological effects, such as to accelerate blood clotting, reduce blood pressure, decrease the serum lipid level and modulate immunoresponses [25]. They are constituents of several drugs because of their astringent property. They may be employed medicinally in anti-diarrhoeal, haemostatic, and anti-haemorrhoidal compounds. Their anti-inflammatory effect helps control all indications of gastritis, esophagitis, enteritis, and irritating bowel disorders [2,26].

The anti-carcinogenic and anti-mutagenic potentials of tannins may be due to their antioxidative property, which is important in preventing cellular oxidative damage, including lipid peroxidation [2,25]. Tannins have antimicrobial activities. They inhibit the growth of many fungi, yeast, bacteria and viruses [2]. Tannic acid and propyl gallate, but no gallic acid, inhibits food borne and aquatic bacteria, and off-flavour-producing microorganisms. This antimicrobial property is due to the hydrolysis of ester linkage between gallic acid and polyols, cleaved after ripening of many edible fruits. Tannins in these fruits thus serve as a natural defense mechanism against microbial infections. The antimicrobial property of tannic acid can also be used in food processing to increase the shelf-life of foods [2,25,26].

Salacia senegalensis leaves have been reported to possess antimalarials activities [27,28] but its carotenoids, phenolic, hydroxycinnamic acids and tannin composition is yet to be reported. Therefore, the aim of this work is to assess the carotenoids, phenolic, hydroxycinnamic acids and tannin contents of the leaves of *Salacia senegalensis* (dry weight) using gas chromatography.

Materials and Methods

Determination of carotenoids composition

They were extracted by the method of Rodriguez-Amaya and Kimura [29] and gas chromatographically analysed.

Phenolic acids determination

The phenolic extract was obtained by the method of Li et al. [30]. The extract methylated with BF_3: MeOH (10). GC-FID analysis was performed to determine the phenolic acid contents.

Determination of the concentration of hydroxycinnamic acids

The extraction was carried according to method of Ortan et al. [31] and analyzed using gas chromatography.

Determination of the concentration of tannins

Extraction was carried out according to the method of Luthar [32] and the dry sample was subjected to gas chromatographic analysis.

Results

Ten known carotenoids were detected as shown in Table 1, mainly lutein (33.48%), carotene (21.31%), viola-xanthin (17.61%), zeaxanthin (15.0%), asta-xanthin (7.19%), beta-cryptoxanthin (1.84%), malvidin (1.64%), anthera-xanthin (0.03%) and lycopene (0.01%). The phenolic acid constituents of *Salacia senegalensis* leaves as shown Table 2 included ferulic acid (52.39%), vanillic acid (44.66%), ellagic acid (1.89%), piperic acid (0.61%), syringic acid (0.23%) and rosmarinio acid (0.23%).

Eight hydroxycinnamic acid were detected which totaling to 5.58 mg/100 g as shown in Table 3. They included mainly caffeic acid (60.08%), p-coumaric acid (39.76%), O-coumaric acid (0.08%), coumarin (0.05%), cinnamic acid (0.02%), and sinapinic acid (0.01%). A total of 162.86 mg/100 g tannin as tannic acid was found in the *Salacia senegalensis* leaf sample (Table 4).

Discussion

Relative high total carotenoids content (19.22 mg/100 g) was noted. Carotenoids are antioxidants, protect against cancer, cataract, and radiation damage, boost the immune system [33,34] and are precursors of vitamin A [35]. β-Carotene is used as food colourant.

The leaves of *Salacia senegalensis* had a total of 19.23 mg/100 g carotenoids as shown in Table 1. Lutein (33.48%) has antioxidant [1], photo-protective [36] and anti-cancer [1,2,37] activities. Carotenes have pro-vitamin A, antioxidant [1] and anti-cancer [2] activities. Lutein and zeaxanthin have been reported to have protective antioxidant effect in the macular region of the human retina [38-40]. Lycopene is an antioxidant-scavenger and destroyers of singlet oxygen [41]. Lycopene also prevents oxidation of low density lipoprotein (LDL) cholesterol and reduces the risk of developing atherosclerosis and coronary heart diseases [42], while asta-xanthin is also an antioxidant [41]. Beta-cryptoxanthin has been shown to have a unique anabolic effect on bone calcification-thus prevent osteoporosis [43-45].

The leaves of *Salacia senegalensis* had relative high content of caffeic acid (60.08%) as presented in Table 2. Caffeic acid has been shown to have neuro-protective and antioxidant properties [46,47]. P-commaric acid found is an antioxidant and reduces stomach cancer by reducing the formation of carcinogenic nitrosamines [48,49]. Coumarin was also found and it is used in the treatment of asthma [50] and lymphedema [51].

Generally, phenolics are important for cell structure, signaling and pigmentation [13]. Phenolic acids (Table 3) are known to act as allelochemicals [14], protect plants against environmental and biological stress such as high energy radiation exposure, bacterial infection or fungal attacks [12], cold stress, hyperthermia [13] and oxidative stress [2]. Therefore, the present results suggest a likely allelopathic potential of *Salacia senegalensis* leaves.

Ferulic acid found has many physiological roles, such as hypo cholesterolemic activity, prevention of coronary diseases, and increasing sperm viability [52].

Vanillic acid (4-hyroxy-3- methoxybenzoic acid) is used as a flavouring agent. It has anti-sickling, anthelmintic, hepatoprotective

Name	Amount (mg/100 g)	**Amount (%)
Malvidin	0.3150850	1.64
Carotene	4.0964900	21.31
Lycopene	0.0010883	0.01
Beta-cryptoxanthin	0.3527960	1.84
Lutein	6.4370100	33.48
Zeaxanthin	2.8979100	15.07
Anthera-xanthin	0.0063927	0.03
Asta-xanthin	1.3826700	7.19
Viola-xanthin	3.3858800	17.61
Neo –xanthin	0.3501600	1.82
Total	**19.2254800 mg/100 g**	

***Percentage is based on the weight of the compounds per the total extract of its family.*

Table 1: Carotenoid composition of *Salacia senegalensis* leaves.

Name	Amount (mg/100 g)	**Amount (%)
Vanillic acid	0.1168070	44.66
Ferulic acid	0.1370260	52.39
Syringic acid	0.0005970	0.23
Piperic acid	0.0015819	0.61
Ellagic acid	0.0049325	1.89
Rosmarinio acid	0.0005967	0.23
Total	**0.2615410 mg/100 g**	

***Percentage is based on the weight of the compounds per the total extract of its family.*

Table 2: Phenolic composition of *Salacia senegalensis* leaves.

Name	Amount (mg/100 g)	**Amount (%)
Cinnamic acid	0.0012745	0.02
Coumarin	0.0027936	0.05
P-coumaric acid	2.2189400	39.76
O-coumaric acid	0.0042574	0.08
Caffeic acid	3.3525900	60.08
Sinapinic acid	0.0003049	0.01
Total	**5.5803800 mg/100 g**	

***Percentage is based on the weight of the compounds per the total extract of its family.*

Table 3: Hydroxycinnamic acid composition of *Salacia senegalensis* leaves.

Name	Amount (mg/100 g)	**Amount (%)
Tannic acid	162.86	100
Total	**162.86 mg/100 g**	

***Percentage is based on the weight of the compounds per the total extract of its family.*

Table 4: Tannin composition of *Salacia senegalensis* leaves.

[53-56], immune-modulating and anti-inflammatory [57] activities. It also, inhibits snake venom 5^{1}-nucleotidase [55,56,58].

The total tannin was relatively high (162.86 mg/100 g). Tannin reduces blood cholesterol [34]. Tannic acid was the only tannin found in the leaves of *Salacia senegalensis* as shown in Table 4. Tannic acid is an antioxidant, hepatoprotective, hypocholesterolemic and hypoglycemic agent [34,50,59,60].

Conclusion

The leaves of *Salacia senegalensis* are rich in these bioactive compounds.

Acknowledgments

Tetfund Nigeria through Imo State Polytechnic is acknowledged.

References

1. Tinoi J, Rakariyatham N, Deming RL (2006) Determination of major carotenoid constituents in petal extracts of eight selected flowering plants in the north of Thailand. Chiang Mai J Sci 33: 327-334.
2. Dillard CJ, German JB (2000) Phytochemicals: nutraceuticals and human health. J Sci Food Agri 80: 1744-1756.
3. Block G, Patterson B, Subar A (1992) Fruit, vegetables, and cancer prevention: a review of the epidemiological evidence. Nutrition and cancer 18: 1-29.
4. Prakash D, Gupta KR (2009) The antioxidant phytochemicals of nutraceutical importance. Open Nutraceuticals J 2: 20-35.
5. Kohlmeier L, Hastings SB (1995) Epidemiologic evidence of a role of carotenoids in cardiovascular disease prevention. Am J Clin Nutr 62: 1370S-1376S.
6. Kris-Etherton PM, Hecker KD, Bonanome A, Coval SM, Binkoski AE, et al. (2002) Bioactive compounds in foods: their role in the prevention of cardiovascular disease and cancer. Am J Med 113: 71-88.
7. Willcox JK, Ash SL, Catignani GL (2004) Antioxidants and prevention of chronic disease. Critical reviews in food science and nutrition 44: 275-295.
8. Houston MC (2002) The role of vascular biology, nutrition and nutraceuticals in the prevention and treatment of hypertension. J Am Nutraceut Assoc 1: 5-70.
9. Houston MC (2005) Nutraceuticals, vitamins, antioxidants, and minerals in the prevention and treatment of hypertension. Prog Cardiovasc Dis 47: 396-449.
10. Houston MC (2007) Treatment of hypertension with nutraceuticals, vitamins, antioxidants and minerals. Expert Rev Cardiovasc Ther 5: 681-691.
11. Marinova D, Ribarova F, Atanassova M (2005) Total phenolics and total flavonoids in Bulgarian fruits and vegetables. Journal of the university of chemical technology and metallurgy 40: 255-260.
12. Tüzen M, Özdemir M (2003) Chromatographic determination of phenolic acids in the snowdrop by HPLC. Turk J Chem 27: 49-54.
13. Adyanthaya I (2007) Antioxidant Response Mechanism in Apples during Post-Harvest Storage and Implications for Human Health Benefits. Masters Theses. University of Massachusetts-Amherst.
14. Yoshioka T, Inokuchi T, Fujioka S, Kimura Y (2004) Phenolic compounds and flavonoids as plant growth regulators from fruit and leaf of Vitex rotundifolia. Z Naturforsch C 59: 509-514.
15. Yang CS, Landau JM, Huang MT, Newmark HL (2001) Inhibition of carcinogenesis by dietary polyphenolic compounds. Ann Rev Nutr 21: 381-406.
16. Pereira DM, Valentão P, Pereira JA, Andrade PB (2009) Phenolics: From chemistry to biology. Molecules 14: 2202-2211.
17. Kennedy JF, Methacanon P, Lloyd LL (1999) The identification and quantitation of the hydroxycinnamic acid substituents of a polysaccharide extracted from maize bran. J Sci Food Agri 79: 464-470.
18. Kono Y, Kobayashi K, Tagawa S, Adachi K, Ueda A, et al. (1997) Antioxidant activity of polyphenolics in diets: rate constants of reactions of chlorogenic acid and caffeic acid with reactive species of oxygen and nitrogen. Biochim Biophys Acta 1335: 335-342.
19. Cheng JC, Dai F, Zhou B, Yang L, Liu ZL (2007) Antioxidant activity of hydroxycinnamic acid derivatives in human low density lipoprotein: mechanism and structure–activity relationship. Food Chem 104: 132-139.
20. Waterhouse AL (2002) Wine phenolics. Ann N Y Acad Sci 957: 21-36.
21. Liu F, Kim JK, Li Y, Liu XQ, Li J, et al. (2001) An extract of Lagerstroemia speciosa L. has insulin-like glucose uptake–stimulatory and adipocyte differentiation–inhibitory activities in 3T3-L1 cells. J Nutr 131: 2242-2247.
22. Muthusamy VS, Anand S, Sangeetha KN, Sujatha S, Arun B, et al. (2008) Tannins present in Cichorium intybus enhance glucose uptake and inhibit adipogenesis in 3T3-L1 adipocytes through PTP1B inhibition. Chem Biol Interact 174: 69-78.
23. Bagchi D, Sen CK, Ray SD, Das DK, Bagchi M, et al. (2003) Molecular mechanisms of cardioprotection by a novel grape seed proanthocyanidin extract. Mutat Res 523: 87-97.
24. Aron PM, Kennedy JA (2008) Flavan-3-ols: Nature, occurrence and biological activity. Mol Nutr Food Res 52: 79-104.
25. Chung KT, Wong TY, Wei CI, Huang YW, Lin Y (1998) Tannins and human health: a review. Crit Rev Food Sci Nutr 38: 421-464.
26. Soetan KO (2008) Pharmacological and other beneficial effects of antinutritional factors in plants-A review. Afr J Biotechnol 7: 4713-4721.
27. Adumanya OCU, Uwakwe AA, Essien EB (2014) Antiplasmodial activity of methanol leaf extract of Salacia senegalensis Lam (Dc) in Albino Mice infected with chloroquine-sensitive Plasmodium berghei berghei (NK65). Int J Biosci Biotechnol Res 1: 1-9.
28. Adumanya OCU, Uwakwe AA, Essien EB (2014) Comparative study on the antimalarial efficacy of Methanol Leaf Extract of Salacia senegalensis Lam (DC) vis-à-vis Chloroquine and Artesunate in Albino Mice infected with Chloroquine-Sensitive Plasmodium berghei berghei (NK65). Int J Curr Res Chem Pharm Sci 1: 45-51.
29. Rodriguez-Amaya DB, Kimura M (2004) Harvest Plus Handbook for Carotenoid Analysis. Harvest Plus Technical Monograph 2. Washington, DC and Cali: International Food Policy Research Institute (IFPRI) and International Centre for Tropical Agriculture (CIAT).
30. Li W, Qiu Y, Patterson CA, Beta T (2011) The analysis of phenolic constituents in glabrous canaryseed groats. Food Chem 127: 10-20.

31. Ortan A, Popescu ML, Gaita AL, Dinu-Pîrvu C, Câmpeanu GH (2009) Contributions to the pharmacognostical study on Anethum graveolens, Dill (Apiaceae). Romanian Biotechnology Letters 14: 4342-4348.

32. Luthar Z (1992) Polyphenol classification and tannin content of buckwheat seeds (Fagopyrum esculentum Moench). Fagopyrum 12: 36-42.

33. Best B (2012) Phytochemicals as nutraceuticals.

34. Basu SK, Thomas JE, Acharya SN (2007) Prospects for growth in global nutraceutical and functional food markets: a Canadian perspective. Aust J Basic Appl Sci 1: 637-649.

35. Chaney SG (2006) Principles of Nutrition 11. Micronutrients. In: Textbook of Biochemistry, with Clinical Correlation. Devlin TM (ed.), 6th edn, John Wiley and Sons, New York, USA, pp: 1091-1120.

36. Pintea A, Bele C, Andrei S, Socaciu C (2003) HPLC analysis of carotenoids in four varieties of Calendula officinalis L. flowers. Acta Biol Szegediensis 47: 37-40.

37. Sertié JA, Basile AC, Panizza S, Matida AK, Zelnik R (1990) Anti-Inflammatory Activity and Sub-Acute Toxicity of Artemetin1. Planta Med 56: 36-40.

38. Snodderly DM (1995) Evidence for protection against age-related macular degeneration by carotenoids and antioxidant vitamins. Am J Clin Nutr 62: 1448S-1461S.

39. Landrum JT, Bonet RA, Kilburn MD (1996) The macular pigment: a possible role in protection from age-related macular degeneration. Adv Pharmacol 38: 537-556.

40. Handelman GJ, Dratz EA, Reay CC, Van Kuijk JG (1988) Carotenoids in the human macula and whole retina. Invest Ophthalmol Vis Sci 29: 850-855.

41. Di Mascio P, Murphy ME, Sies H (1991) Antioxidant Defense System: The Role of Carotenoids, Tocopherol, and Thiols. Am J Clin Nutr 53: 194S-200S.

42. Agarwal S, Rao AV (1998) Tomato lycopene and low density lipoprotein oxidation: a human dietary intervention study. Lipids 33: 981-984.

43. Yamaguchi M, Uchiyama S (2003) Effect of Carotenoid on Calcium Content and Alkaline Phosphatase Activity in Rat Femoral Tissues in vitro: The Unique Anabolic Effect of beta-Cryptoxanthin. Biol Pharm Bull 26: 1188-1191.

44. Yamaguchi M, Uchiyama S (2004) ß-cryptoxathin Stimulates Bone Resorption in Tissue Culture in vitro. Mol Cell Biochem 258: 137-144.

45. Yamaguchi M, Hamanoto R, Uchiyama S, Ishiyama K, Hashimoto K (2006) Anabolic Effects of Bee Pollen Citus ladaniferusExtract on Bone Components in the Femoral-diaphyseal and Metaphyseal Tissue of Rats in vitro and in vivo. J Health Sci 52: 43-49.

46. Chang-HO J, Hee RJ, Gwi NC, Dae-OK K, UK L, et al. (2011) Neuroprotective and Antioxidant Effects of Caffeic acid Isolated from Erigeron annuus leaf. Chinese Medicine 6: 25.

47. Olthof MR, Hollman PC, Katan MB (2001) Chlorogenic acid and Caffeic acid are Absorbed in Humans. J Nutr 131: 66-71.

48. Kikugawa K, Hakamada T, Hasunuma M, Kurechi T (1983) Reaction of p-hydroxycinnamic acid Derivatives with Nitrite and its Relevance to Nitrosamine Formation. J of Agri and Food Chem 1: 780-785.

49. Ferguson LR, Shuo-tun Z, Harris PJ (2005) Antioxidant and Antigenotoxic Effects of Plant Cell Wall Hydroxycinnamic acids in Cultured HT-29. Mol Nut and Food Res 49: 585-639.

50. Liu X, Kim JK, Li J, Liu F, Chen X (2005) Tannic acid Stimulates Glucose Transport and Inhibits Adipocyte Differentiation in 3T3-Li cells. Journal of Nutrition 135: 165-171.

51. Farinola M, Piller M (2005) Pharmacogenomics: Its Role in Re-establishing Coumarin as Treatment for Lymphedema. Lymp Res and Biol 3: 81-86.

52. Shiyi OU, Kin-Chor K (2004) Ferulic acid: Pharmaceutical Functions, Preparation and Applications in Foods. J of the Sci of Food and Agri 84: 1261-1269.

53. Itoh A, Isoda K, Kondoh M, Kawase M, Kobayashi M, et al. (2009) Heptoprotective Effect of Syringic acid and Vanillic acid on Concanavalin a-induced Liver Injury. Biol and Pharm Bulletin 32: 1215-1219.

54. Itoh A, Isoda K, Kondoh M, Kawase M, Watari A, et al. (2010) Hepatoprotective Effect of Syringic acid and Vanillic acid on CCL4-induced Liver Injury. Biol and Pharm Bulletin 33: 983-987.

55. Khadem S, Marles RJ (2010) Monocyclic Phenolic acids; Hydroxy-and Polyhydroxybenzoic acids: Occurrence and Recent Bioactivity Studies. Molecules 15: 7985-8005.

56. Oksana S, Marian B, Mahendra R, Bo SH (2012) Plant Phenolic Compounds for Food, Pharmaceutical and Cosmetics Production. J of Medi Plants Res 6: 2526-2539.

57. Chiang LC, Ng LT, Chiang W, Chang MY, Lin CC (2003) Immunomodulatory Activities of Flavonoids, Monoterpenoids, Triterpenoids, Iridoid Glycosides and Phenolic Compounds of Plantago species. Planta Med 69: 600-604.

58. Dhananjaya BL, Mataraju A, Raghavendra Gowda CD, Sharath BK, D'souza CJ (2009) Vanillic acid as a Novel Specific Inhibitor of Snake Venom 51-nucleotidase: APharmacological Tool in Evaluating the Role of the Enzyme in Snake Envenomation. Biochemistry (Moscow) 74: 1315-1319.

59. Mittal DK, Joshi D, Shukla S (2010) Protective Effects of Polygonum biostora (Linn.) and its Active Principle Against Acetaminophen-induced Toxicity in Rats. Asian J Exp Biol Sci 1: 951-958.

60. Di Mascio P, Kaiser S, Sies H (1989) Lycopene as the Most Efficient Biological Carotenoid Singlet Oxygen Quencher. Arch Biochem Biophys 274: 532-532.

Citation: Adumanya OCU (2016) Carotenoids, Phenolics, Hydroxycinnamic Acids and Tannin Composition of *Salacia senegalensis* (Lam) DC Leaves. Nat Prod Chem Res 5: 246. doi: 10.4172/2329-6836.1000246