Journal of Contemporary Issues in Business and Government Vol. 25, No. 01, 2019
https://cibgp.com/

P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2019.25.01.028

Protocatechuic acid and aldehyde's antioxidant properties are like "new wine in old bottles."

[1]PENDYALA KALYANI,Assoiate Prof, Ph.D,

kalyani.dhara@gmail.com,

[2]DHANUNJAYA RAO KODALI,Asst.Prof, M.Sc.M.Tech,

kodalidhana@gmail.com,

[3]Dr. KUMMARI SRINIVAS, Associate .Prof,M.SC., Ph. D,

Kummari.srinivas@dpssecunderabad.in,

[4]MOHAMAD JAHANGIR PASHA,Asst.Prof, M.Sc.,

jahangir.475@gmail.com,

Pallavi Engineering College,

Kuntloor(V),Hayathnagar(M),Hyderabad,R.R.Dist.-501505.

ABSTRACT

Phenolic compounds are a kind of secondary metabolite found in foods including fruits, vegetables, and spices. Due to their antioxidant, anti-inflammatory, and anti-carcinogenic qualities, they have attracted a lot of interest as a means of protection against a wide range of chronic illnesses. Classed according to their chemical make-up into several categories that include phenolic acids, flavonoids, curcumins, tannins, and antioxidant feature of quinolones..eir structural differences lead to their unique positive benefits on human health. through increasing the production of natural antioxidants, scavenging for free radicals, and generally being all-around good at keeping things from oxidizing too quickly, phenolic chemicals provide protection against oxidative stress. Resistance to apoptosis. 3, 4-dihydroxy benzoic acid, also known as protocatechuic acid (PCA), and protocatechuic aldehyde (PAL; 3,4-dihydroxybenzaldehyde) are polyphenols that grow naturally in produce and plants.

Introduction

P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2019.25.01.028

Some plant-based foods and drinks include polyphenols, which are believed to have positive benefits on human health. functions in a wide variety of metabolic and physiological activities Some of the benefits of [1] include lowering the likelihood of developing a number of ailments, a variety of cancers, heart disease, dementia, and other neurological conditions type 2 diabetes in people [2, 3]. This acid, known as protocatechuic acid (PCA; and protocatechuic aldehyde (3,4-dihydroxybenzoic acid) The major metabolites are (PAL; 3,4-dihydroxybenzaldehyde). vegetal sources of the polyphenolic compounds [3] produce and greenery. In chemistry, PCA is a benzoic acid derivative that dissolves in water. anti-atherosclerotic (Figure 1), functions as an anti-inflammatory, an anti-cancer, an analgesic, and an anti-bacterial. Protective effects on the liver, antiviral properties and impacts on living organisms (in vivo) laboratory experiments on simulated human cells in vitro [6, 7]. It's crucial in turning around the alterations in biochemistry caused by heart dysfunction, and type 2 diabetes [7] and related metabolic condition contains a lot of fat [8]. Natural phenolic acid (PAL) that dissolves in water. aldehyde (Figure 1) is another substance found in nature. Caused by the breakdown of phenolic acids [9]. PAL is antiadipogenic, antiproliferative, and anti-inflammatory effects have been documented. Characteristics, both in vivo and in vitro [10-15]

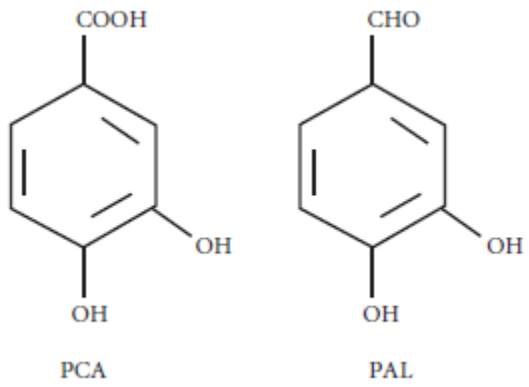


Figure 1: Chemical structure of protocatechuic acid (PCA) and protocatechuic aldehyde (PAL).

Antioxidant properties of PCA and PAL were recently validated in numerous disorders, giving these "ancient chemicals" a possible "new use" in medical practice. Therapies. The antioxidant

P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2019.25.01.028

processes in their bodies, however, are difficult to grasp [3]. In this article, we make an effort to bridge this gap. Education by examining the state of research on antioxidative consequences, and how these effects and processes work compounds in illnesses of the central nervous system, cardiovascular disease, diabetes, liver damage, cancer, excessive weight, and obesity promise in treating other disorders, uses in medicine.

Source

Natural PCA and PAL 2. Vegetables, fruits, plant-based drinks, and herbal remedies all often include PCA and PAL since these compounds occur naturally in these foods. Therapeutics [1, 16]. Table 1 shows the locations where they may be found. Coloured rice bran, hemp, and other grains and legumes and pulses [17-21]. Additionally, kidney beans and [21] mung beans; [22] dried onion bulb skin extract; [23] quercetin, an antioxidant, has been found in the layer. PCA condensation products [22]. Basil (Osmium basilicum), Herbs like lemon thyme ($ymus citriodorus) and mint (Mentha species), members of the mint family, that have culinary uses the antioxidant and anti-inflammatory properties of herbs are well recognized. Substances with phenol groups, such PCA and PAL along with a number of others [23-26]. Foods such as the friar plum and walnut, grapes, gooseberries, currants, and the prune (Prunus domestica L.) in addition to Prunus persica var. platycarpa (Tabacchiera peach) are composed of PCA and PAL [27-31]. Extraction of PCA is possible as well. Prepared with Prunus amygdalus Batch (almond) hulls [32]. There are 15 phenolic chemicals in cocoa beans, and they include Products of Cellular Autolysis and Lipid Accumulation [PCA and PAL] [33]; i.e., Plant and Fruit Products drinks like Hibiscus sabdariffa L. (Hs, hibiscus) (both hot and cold), barley tea, drinks (roselle; Malvaceae) [34–37], the extracted crude oil originated from acai fruits (Euterpe oleracea) [38], and were intentionally bred in It was also discovered that Emblica wine [39] and red wine [40] plant parts that contain phenylacetic acid and palatable acetolactate Traditional Chinese Medicine (TCM) is known to include the bioactive PCA and PAL Subcomponents.

As well as Ginkgo biloba L [41-43] and the plants Hypericum perforatum [44] and Pinellia ternate PAL may be found in both [45] and [46] Lilium lancifolium. Traditional Chinese Medicines [47] and the Cynomorium songaricum Rupr. Phycocyanin and Anthocyanin (PCA and ACC) are found in the fruiting body of Phellinus linteus [48]. When asked to name the most

P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2019.25.01.028

well-known and widely-used programming language, most people would choose PAL. Salvia miltiorrhiza (SM), sometimes called Danshen in Traditional Chinese Medicine (TCM), Chinese. The phenolic acids and diterpenoids it contains are diverse. Containing notably more PCA (1.43 mg/g) and PAL (0.02 mg/g) 1.73 mg/g [49]. As previously mentioned, PAL has been shown to play an ingredient in SM and the primary byproduct of manufacturing Salvianolic acid B, the active ingredient, is water-soluble. Various plant tissues have varying levels of PCA and PAL. PCA is found at a concentration of 0.832 mg/kg fresh weight in However, the average amount of alpine oxyphylla (AOF) fruit contains only approximately 11.3 mg/kg contained in its kernels after air drying [51, 52].

Mechanism of Antioxidant Effects

Reactive oxygen species (ROS), also known as free radicals, accumulate as a byproduct of metabolic activities and have been linked to the pathophysiology of oxidative stress. Cardiovascular disease, diabetes, and cancer are just a few examples antioxidants have been shown to be effective against cancer and neurological illnesses. Perform their functions through either direct or indirect means features, including as reactive oxygen species (ROS) scavenging and intracellular enzymatic a response [90]. Since they have a short half-life and are redox-active, and pay the price for it when they respond to ROS signals renewed to reduce reactive oxygen species. A scavenger of free radicals action may set off the body's natural defences

Table 1: Sources of PCA and PAL in nature and their biological activities.

P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2019.25.01.028

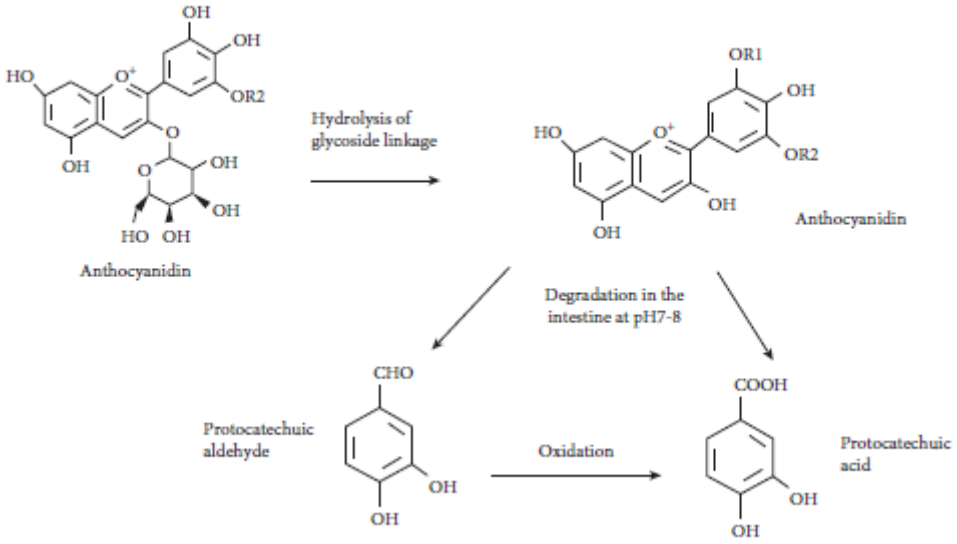
No.	Biological source	PCA content (ug/g)	PAL content (ug/g)	Biological activity	References
1	Rice	23.2–1043 (DW)	2–188 (DW)	Antioxidative, anti-inflammatory chemoprevention	[18, 60, 61]
2	Buckwheat (*Fagopyrum esculentum*)	6.61–24.5 (DW)	3.65–19.74 (DW)	Antioxidative	[21, 62]
3	Green pea (*Pisum sativum*)	1.26–11.38 (DW)	0.07–0.12 (DW)	Antioxidative	[21, 63]
4	Fava bean (*Vicia faba*)	0.61–2.42 (DW)	0.68–5.63 (DW)	NT	[21]
5	Hemp (*Cannabis sativa*)	5.63–22.06 (DW)	6.41–34.77 (DW)	NT	[21]
6	Lupin (*Lupinus albus*)	0.15 ± 0.02 (DW)	ND	NT	[21]
7	Wheat	0.07–0.11 (DW)	0.19 ± 0.04 (DW)	Antioxidative	[21]
8	Lentils	20.28–37.72 (DW)	3.69–12.14 (DW)	Antioxidative, anti-inflammatory	[20]
9	Commercial black-colored cowpeas	18.97 ± 0.45 (DW)	NT	Antioxidative antidiabetic	[64]
10	Pea (*Pisum sativum* L.) varieties	12.1–163.5 (DW)	NT	Antioxidative, anti-inflammatory immunomodulation	[65]
11	Common beans	95.34–253.42 (DW)	NT	Antioxidative	[66]
12	Onion (*Allium cepa* L.)	1027 (DW)	NT	Antioxidative, antimutagenic	[22]
13	Mint family plants	UC (FW)	0.843–18.285 (FW)	Antioxidative, anti-inflammatory	[26]
14	Yayla Cayi (*Thymus praecox* OPIZ subsp. Grossheimii (Ronniger) Jalas)	UC (DW)	UC (DW)	Antioxidative	[67]
15	Loquat (*Eriobotrya japonica* L.)	0.843–18.285 (DW)	NT	Antioxidative	[68]
16	Kinnow peel	177 (DW)	NT	Antioxidative, health benefits	[69]
17	Banana pulp	340 (DW)	NT	Antioxidative, health benefits	[69]
18	Prune (*Prunus domestica* L.)	355.87 (FW)	NT	Antioxidative	[27]
19	Friar plum (*Prunus salicina* Lindl.)	50–160 (FW)	NT	Antioxidative, increased edible quality	[28]
20	*Prunus persica* var. platycarpa (Tabacchiera peach)	0.19 (FW)	0.02 (FW)	Antioxidative	[31]
21	Currant (*Ribes* L.)	137.6–464.8 (FW)	NT	Antioxidative	[30]
22	Gooseberry (*Ribes uva-crispa* L.)	24.7–77.7 (DW)	NT	Antioxidative	[30]
23	Grapes	0.143–0.371 (FW)	NT	Antioxidative	[29]
24	Acai (*Euterpe oleracea* Mart.) seed	106–843 (DW)	NT	Antioxidative, antimalarial, antiplasmodial	[70]
25	Cocoa beans	197.9–385.3 (DW)	2.6–1945.7 (DW)	Antioxidative, anti-inflammatory	[33]
26	Almonds (*Prunus amygdalus* Batsch)	66.67 (DW)	NT	Antioxidative	[71]
27	Pecan (*Carya illinoinensis*)	13.1–30.5 (FW)	UC	Antioxidative	[72]
28	*Orobanche cernua* Loefling (Orobanchaceae)	NT	0.353 (FW)	Anticancer	[73]
29	*Salvia miltiorrhiza*	56 ~ 152 (DW)	59 ~ 94 (DW)	Antioxidative, anti-inflammatory	[49]
30	The fruiting body of *Phellinus linteus*	10 (FW)	9 (FW)	Aldose reductase inhibitors	[48]
31	*Ginkgo biloba* L. leaf	2708 ~ 345321 (FW)	NT	Antioxidative	[42, 43]
32	*Aesculus hippocastanum* L. (Hippocastanaceae)	72.53 (DW)	NT	Antioxidative	[44]
33	*Hypericum perforatum*	761.67 (DW)	NT	Antioxidative, anti-inflammatory, antigenotoxic	[44]
34	Alpinate oxyphyllae fructus (*Alpinia oxyphylla* MIQ, AOF)	0.832 (FW), 8.5 (DW)	NT	Antioxidative, anti-cell migration, antiapoptosis	[51, 74]
35	*Schisandra chinensis* (Turcz.) Baill. fructus (SCF)	210 (DW)	NT	Antioxidative, anti-beta amyloid formation	[75, 76]
36	Ramulus Cinnamomi	61.5 ~ 137.7 (DW)	NT	Antioxidative	[77]
37	Cinnamon fruits	54.7 (DW)	NT	Antioxidative	[78]
38	*Lilium lancifolium*	0.5937 ~ 2.962 (DW)	NT	Antioxidative	[46]
39	*Cynomorium songaricum* Rupr.	148 (DW)	0.629 (DW)	Phytoestrogenic- or phytoandrogenic-like activities	[47]

P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2019.25.01.028

Table 1: Continued.

No.	Biological source	PCA content (ug/g)	PAL content (ug/g)	Biological activity	References
40	The fruiting bodies of *Ganoderma lucidum*	NT	0.952 (DW)?	Aldose reductase inhibitors	[79]
41	*Pinellia ternata*	NT	UC	Antioxidative, change of activity of protective enzyme	[45, 80]
42	*Prunella vulgaris*	0.0089 ~ 0.0476% (w/w)	0.003 ~ 0.008% (w/w)	Antioxidative	[81]
43	Black cohosh (*Actaea racemosa* L.)	8.8 (DW)	4.6 (DW)	Antioxidative, anticancer	[82]
44	Rattan materials (*Calamoideae faberii*)	14 ~ 97 (DW)	18 ~ 99 (DW)	Antioxidative	[83]
45	Leaves of *Lycium barbarum*	NT	0.87 ~ 9.47 (DW)	Antioxidative	[84, 85]
46	*Hydnophytum formicarum* Jack. (Rubiaceae)	NT	1.5 (DW)	Antioxidative, antimicrobial	[86]
47	*Hibiscus sabdariffa* L. (*Hs*, Roselle; Malvaceae)	94.1 (DW)	NT	Antioxidative, anti-inflammatory, antiurease	[87, 88]
48	Echinacea (*Echinacea* purpurea)	UC	UC	Antioxidative, anti-inflammatory	[67]
49	Green tea (*Camellia sinensis*)	UC	UC	Antioxidative, anti-inflammatory	[67]
50	Barley tea	NT	2.6 (DW)	Antioxidative, anti-inflammatory	[89]
51	Grape wine	0.7 ~ 5.24 mg/L	NT	Antioxidative, anti-inflammatory	[39, 40]
52	Olive oil (*Olea europaea*)	176.08 (DW)	NT	Antioxidative, anti-inflammatory	[44]

DW, dry weight; FW, fresh weight; ND, not detected (i.e., below the detection level); NT, not tested; UC, detected, but content unclear.



Metabolism of anthocyanins into PCA and PAL is shown in Figure 2. In this illustration, we see a common anthocyanin with a glucoside moiety. In the small intestine, hydrolysis of glycoside bonds transforms parent anthocyanin species into a glycol (anthocyanidin). Intestinal microorganisms might oxidize PAL to PCA.

P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2019.25.01.028

Anti-oxidative stress pathways. Mitochondria undergo morphological and functional changes as a result of the oxidative stress, which in turn causes an increase in reactive oxygen species (ROS) production and a loss in energy. changes in calcium homeostasis and ATP generation, and the activation of programmed cell death (apoptosis) enhancing the performance of PCA and PAL to their full glutathione peroxidase and other endogenous antioxidant enzymes superoxide dismutase (SOD) and glutathione peroxidase (GSH-PX) recent research shows. In addition to being the gold standard, PCA is used neutralizer of peroxyl radicals in cold climates water-based remedies, with a potent free-radical shield lipid solutions' nonpolar environment [92]. It is ability to reduce oxidative damage by boosting in addition to lowering the activity of GSH-PX and SOD, combination of xanthine oxidase (XOD) and nitric oxide syntheses (NOX) increases in malondialdehyde (MDA) [5, 93] concentrations. PAL was shown to reduce reactive oxygen species in rat PC12 cells. human SH-SY5Y cells, and mouse fibroblasts [94, 95]. 2nd and 3rd Tables please describe PCA's and PAL's antioxidant activities in vitro and in vivo. The antioxidant processes of the 2 metabolites are shown in Figure 3 through activation of a wide variety of transcription factors across organs, tissues, organs.

Characteristic Antioxidants in CNS Disorders 3.1. Because of their high metabolic activity, brain nerve cells are especially susceptible to damage from reactive oxygen species (ROS). Or weakened antioxidant defenses, causes degenerative illnesses of the nervous system and mental problems these include anti-aging, antioxidant, and anti-inflammatory properties [96–98]. both PCA and PAL characteristics have been researched extensively in degenerative neurological disorders like Parkinson's disease (AD) [3, 4, 99-101], dementia, and Parkinson's disease trauma illnesses including intracranial haemorrhage (ICH) and epilepsy, cerebral ischemia-reperfusion, and depression Diabetic oxidative stress in the brain [106] as well as cadmium (Cd)-induced cortical toxicity [108], in both in vitro and in vivo

Neurodegenerative Disorders, Section 3.1.1. The neurodegenerative disorders that share symptoms with Alzheimer's disease (AD) and Parkinson's disease (PD) include slow but steady deterioration of neuronal health and function. Three main causes of neuroinflammation are oxidative stress, mitochondrial malfunction, and neuroinflammation. Significantly contribute to

P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2019.25.01.028

the etiology of these disorders, the prevalence of which may be decreased by early intervention dangers resulting from insufficient medications suitable for therapeutic use. In the recent years have seen an increase in the usage of natural remedies significance of these illnesses has grown as a result of possess neuroprotective qualities including antioxidation and impact on reducing inflammation [109]. PCA may be able to reduce neuroinflammation, excitotoxicity, and oxidative damage also, the consequences of nitrosative stress [110]. It has shown to greatly slow down the deterioration of nerve cells and movement impairments in a mouse model of Parkinson's disease generated by MPTP. There are likely many factors at play in benefiting the body's defences. Researchers have shown that using PCA may boost expression of nuclear factor erythroid 2-related factor 2 (Nrf2) modify cellular expression and transcriptional activity changes in redox state and the increased expression of signature enzymes that fight free radicals, like heme oxygenase-1 (HO-1), Catalase (CAT) and superoxide dismutase (SOD) reduce MDA levels in treated It's PC12 cells [102]. Inhibition was also seen after PCA treatment. The expression and activation of nuclear factor kappa B ions, or inducible nitric oxide syntheses, [102].

Table 2: Summary of the effects on antioxidants of PCA and PAL in vitro.

P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2019.25.01.028

Disease model	PCA/PAL dosages	Model used	Oxidative stress mechanisms	References
Neurodegenerative diseases	PCA (50, 100, 150, and 200 μg/ml)	H_2O_2-treated PC12 cells	Downregulation of lipid peroxidation and upregulation of glutathione peroxidase and superoxide dismutase activity	[118]
PD	PAL (20 μM)	H_2O_2-treated SH-SY5Y cells	Activation of the Akt pathway and suppression of excessive DJ-1 oxidation	[95]
PD	PCA (1 mM)	6-OHDA-treated PC12 cells	Activation of Nrf2/HO-1 and suppression of NF-κB signaling	[102]
PD	PCA (10 μM)	MPP-treated SH-SY5Y cells	Mitigation of oxidative damage and mitochondrial dysfunction through PLK2/p-GSK3β/Nrf2 pathway	[101]
PD	PAL (1, 10, and 100 μM/0.1, 1, and 10 μM)	H_2O_2/6-OHDA-treated PC12 cells	Induction of DJ-1 and reduction of a-synuclein expression	[100]
Diabetic cataract	PAL (20 and 50 μg/ml)	High glucose- or S100b-treated human lens epithelial cells	Inhibition of TGF-β1 expression and pSmad2/3 nuclear accumulation	[135]
Cerebral I/R injury	PAL (80 μM)	Differentiated SH-SY5Y cells	Induction of Nrf2 nuclear translocation and HO-1 upregulation	[104]
CVD	PCA (10, 50, and 100 μM)	Palmitic acid- (PA-) treated HUVECs.	Suppression of Ac-CoA or Sirt1 and Sirt3 activation through CD36/AMPK signaling	[146]
CVD	PAL (100 μM)	Thoracic aortic smooth muscle cells	Inhibition of PDGF and other cytokines cascade signaling	[15]
CVD	PCA (10–100 μM)	PA-treated HUVECs	Induction of HO-1 and increasing SOD and GPx-1 activity through LKB1-AMPK-Nrf2 pathway	[145]
Atherosclerosis	PAL (10, 50, or 100 μM)	HUVECS	Reduction of ROS activity and inflammation, increase of cAMP and GPER-1	[143]
Ischemic injury	PCA (10, 20, and 40 μM)	H_2O_2 treat H9C2 cells	Reduction of ROS and elevation of GSH	[148]
Liver injury	PCA (2.5, 5, and 10 μM)	PA-treated AML-12 cells	Activation of SIRT3 and suppression of ACSF3-mediated fatty acid metabolism disorder	[150]
Liver injury	PCA (10 μM)	Primary hepatocytes, AML-12 cells	Upregulation of miR-219a-5p expression and suppression of p66shc-mediated ROS formation	[149]
Liver injury	PCA 20 ug/ml, PAL 20 ug/ml	Ccl4 treatment isolated rat hepatocytes	Inhibit MDA production in liver microsomes and peroxidative damage to the surfaces of rat hepatocytes.	[156]
Cancer	PCA (500 ppm)	N-nitroso-methyl benzylamine- (NMBA-) induced esophageal tumorigenesis	Inhibition of tumorigenesis and inflammatory signaling	[160]

Alternate Disorders of the Brain and Spinal Cord 3.1.3. In rats exposed to stress, PCA showed antidepressant effects. It boosted naturally occurring antidepressant and antioxidant enzymes. Brain functions by increasing their expression hormones [118, 120] that stimulate the production of monoamines. PCA (100, 200 mg/kg body weight) lowered oxidative activity by dampening formation of MDA, activation of antioxidant enzymes, the dampening of IL-6 and other pro-inflammatory cytokines cortical and hippocampus TNF- expression in patients with acute The odorant response in mice subjected to a model of restraint stress (ARS) depression in the ovariohysterectomy (OBX) mice model [5, 121, Antioxidant activities were boosted, cholesterol levels were lowered, and inflammation was reduced by PCA [n=122]. reduced peroxidation and serum corticosterone levels ARS-infected Swiss albino mice.

P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2019.25.01.028

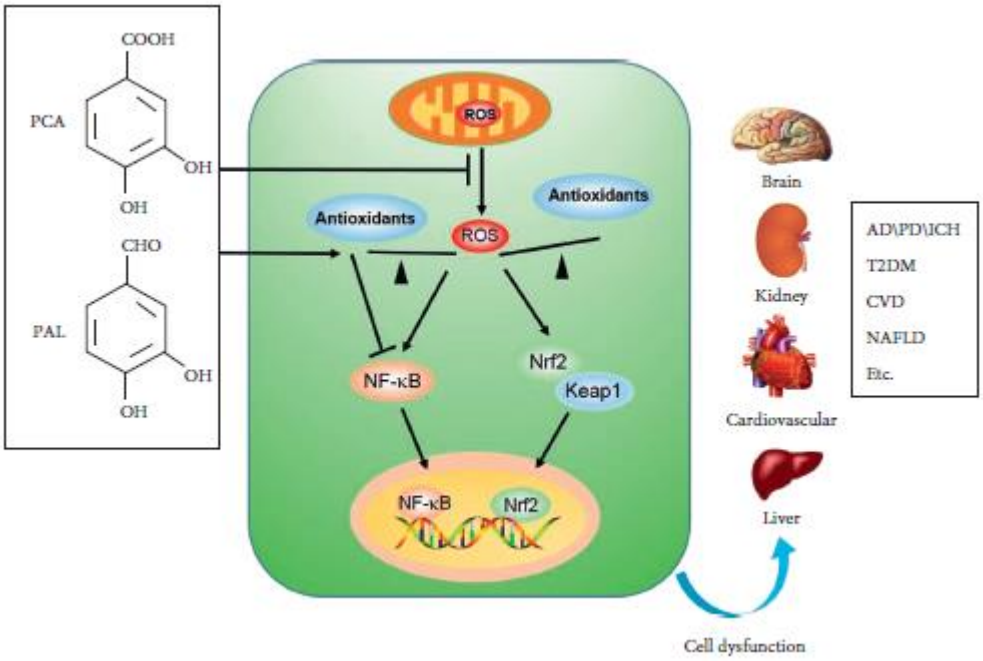


Figure 3: Antioxidant mechanisms of PCA and PAL.

Positive Antioxidant Effects in Diabetics 3.2. A serious result of type 2 diabetes mellitus is heart failure, medically referred to as diabetic cardiomyopathy (DC) (T2DM). Free radicals and oxidative reports of cardiac stress in people with diabetes are rising. Hyperlipidemia was associated with high levels of oxidative stress, suggesting that fatty acids were involved in the production of reactive oxygen species When PCA was used to treat patients, oxidative stress was prevented from Observed Increase in Reactive Oxygen Species Caused by Lipids and Proteins in T2D rat cardiac tissues. The Protein Coding Area Was Regulated Higher. myocardial function through endogenous antioxidants and restoration of function signaling between phosphoinositide 3-kinase (PI3K), cyclin-dependent kinase (CDK), and anti-inflammatory, antioxidant, and pathway-mediated in addition to their hypoglycemic and insulin-sensitizing properties, improved cholesterol and glucose homeostasis and increased glucose metabolism muscle insulin resistance and glycemic control through the IRS1 and PI3K/AKT signaling pathways (AKT/AMPK/GLUT4)/(P38) in diabetes oxygen radical stress-induced cardiac dysfunction treatment with oral PCA cured hyperglycemia caused by streptozotocin in rats. antioxidant and

P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2019.25.01.028

anti-inflammatory properties, therapy (50 or 100 mg/kg/day) actions against hyperglycemia [126, 127]. Multiple PCA injections lowered glucose and A1C levels as a result of its hypoglycemic effects [127-129].

Effects of Antioxidants on Cardiovascular Illnesses 3.3.

Given that PCA reduced the 2,3,7,8-tetrahydroquinoline-5-carboxylate (TCQ) in hypertrophic cardiomyopathy, it may be a viable treatment choice. cardiotoxicity caused by tetrachlorodibenzo-p-dioxin (TCDD) via downregulating thiobarbituric acid reactive-substances (TBARS) and increasing GSH-PX, GSH, and GSSG expression. Tissue levels of SOD and CAT in the heart of rats [136]. The effect was repressive. Decreased hypoxia and cleaved caspase-3 expression rate of cardiomyocyte apoptosis produced by reoxygenation [136]. The anti-oxidant effects of PCA and glibenclamide treatment were decrease in low-density lipoprotein (LDL) cholesterol, and reduction in total cholesterol (TC) very low-density lipoprotein cholesterol (VLDL-C) Very Low Density Lipoprotein Cholesterol, Triglyceride, and diabetes-induced oxidative stress and lipid peroxidation Heart problems [127, 138]. 12 Months of PCA Treatment weeks increased insulin and IGF-1-induced endothelium-dependent vasodilation in primary hypertensive patients the PI3K-NOS-NO pathway in male rats [139]. Hypoglycemic, Insulin Sensitizing, Hypolipidemic, an anti-inflammatory and antioxidant role in glucocorticoid (GC)-induced Rats with high blood pressure [140]

Clinical Studies of PCA and PAL in TCM

Salviae miltiorrhiza (Danshen) and Acanthopanax senticosus (Ciwujia) are only two examples of the numerous traditional Chinese remedies that include PCA and PAL as their active constituents. Identified in a Traditional Chinese Herbal Formula compounds, and injections like the Danshen (DSI) and Compound Injection of Danshen (CDSI), Xiangdan (CDSI), and other (XDI), Injections of Guanxinning (GXN) and Danhong (DNH) (DHI), and the XueBiJing (XBJ) injection. ese is really popular at the moment. Among the several cardiovascular conditions treated acute coronary (such as hypertensive emergency syndrome and angina pectoris) and cerebrovascular disorders (like stroke) in China for a long time. Their Pharmacological Effects Antioxidant, as well as other characteristics, is all connected to PCA and PAL. Actions against

P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2019.25.01.028

blood clots, low cholesterol levels, and cell death immune-boosting, blood vessel-opening, and antigenic behavior [175].

Salviae miltiorrhiza is the sole ingredient in DSI. Both Danshen and Dalbergia make up CDSI and XDI. odorifera (Jiangxiang). Two well-known Chinese individuals make up DHI. Drugs derived from plants, such as Danshen and Carthami flos (Honghua) to make GXN, you need to boil down some dried Dan Shen and Rhizoma Chuanxiong (Chuan xiong). Research suggests that Danshen is the primary active ingredient in these injections. With rather high PCA and PAL concentrations [175, 177-180]. Similar to XBJ, a total of 17 Danshen catechols were determined, with PCA and PAL concentrations being Acanthopanax senticosus extract injection, resulting in a high (ASI) also has a plethora of chemicals, PCA being one among them [182]. PAL may be converted to PCA in high amounts in the body; PCA has several uses and is widely while its concentration is modest in the injection, it is a circulating metabolite.

4.1.1 The Antioxidant Impact on Neurodegenerative Disorders.

Patients undergoing CABG surgery with cardiopulmonary bypass are less likely to get brain injuries when DHI is used. via antioxidant, anti-inflammatory, and cytoprotective method for controlling immune factor production [183, 183]. Composite Researchers have shown that a salvia injection (CSI) may be able to help lower the repair oxygen-free radical damage and control apolipoprotein brain injury sufferers' metabolic rate by reduced lipid peroxide (LPO) in the blood and boosting the SOD and apolipoprotein B100 (APOB100) , ApoA1, and levels [185]. Furthermore, it has been seen to effectively the serum levels of MPO and hypersensitive C-reactive Protein high-sensitivity C-reactive protein (hs-CRP) in individuals with severe preeclampsia (PE) [186].

The Role of Antioxidants in Type 2 Diabetes Mellitus 4.2 A protective effect of CWJI exists in individuals with type 2 diabetes (T2DM) who have chronic microalbuminuria and lowers blood pressure by blocking a protein produced in the kidneys called endothelin (ET) synthesis, decreasing albumin excretion in the urine in terms of urine ET excretion, plasma ET concentration, and UAE [187]. The integration of CSI with conventional medical practices was

P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2019.25.01.028

useful in the management of diabetic foot conditions by quickening the pace of the median nerve's motor and sensory transmission accelerating impulse transmission and decreasing blood viscosity [188].

The Impact of Antioxidants on Cardiovascular Illnesses. Common uses for GXN include the treatment of angina, high cholesterol, and cardiac disease [189, 190]. Assuming a stable chronic condition, when patients with angina were given DHI, they had a statistically and clinically significant improvement in their symptoms. A 20-point increase is considered a big shift. The Seattle Angina Questionnaire measures the frequency with which patients experience angina Other Secondary Efficacy and Safety Questionnaire the results were evaluated simultaneously [191]. DSI enhanced vascular reactivity and reduced endothelin-1 (ET-1) response Stability of hemodynamics postoperatively; diminished myocardial injury; and restored equilibrium to vasoactive mediators after congenital heart surgery in children defects in the heart [192]. In addition to enhancing plasma nitric oxide synthase (NOS) and extracellular matrix metalloproteinase reductions in nitric oxide (NO), as well as apolipoprotein, clinical manifestations of arterial hardening to wipe out (ASO) [120]. Administering Shenmai-Danshen (SM-DS) increased levels of MDA, SOD, IL-6, and TNF-alpha levels and reduced the reperfusion damage to the myocardium The results of percutaneous coronary intervention in individuals with acute myocardial infarction catheterization and angioplasty (CABG) [193] for blocked arteries in the heart.

The Role of Antioxidants in Hepatic Disorders. Liver fibrosis and cirrhosis caused by chronic hepatitis B virus infection responded well to DSI [199-201], and intrahepatic steroid injections were also successful. Inhibitory effect on reactive oxygen species (ROS) generation [202] in patients with intrahepatic cholestasis (ICP). Serum inflammatory cytokines were blocked by XBJ. Cytokines, which reduce hepatic I/R damage and stimulate liver regeneration. Repair of intestines, however that did not happen. Be protective against coagulopathy [203].

References

P-ISSN: 2204-1990; E-ISSN: 1323-6903
DOI: 10.47750/cibg.2019.25.01.028

[1] B. Singh, J. P. Singh, A. Kaur, and N. Singh, "Phenolic composition and antioxidant potential of grain legume seeds: a review," Food Research International, vol. 101 pp. 1–16, 2017.

[2] C. Scholl, A. Lepper, T. Lehr et al., "Population nutrikinetic of green tea extract," PLoS One, vol. 13, no. 2, Article ID e0193074, 2018.

[3] S. Kakkar and S. Bais, "A review on protocatechuic Acid and its pharmacological potential," ISRN Pharmacology, vol. 2014, Article ID 952943, 2014.

[4] Y. Semaming, P. Pannengpetch, S. C. Chattipakorn, and N. Chattipakorn, "Pharmacological properties of protocatechuic Acid and its potential roles as complementary medicine," Evidence-Based Complementary and Alternative Medicine, vol. 2015, Article ID 593902, 2015.

[5] K. Krzysztoforska, D. Mirowska-Guzel, and E. Widy-Tyszkiewicz, "Pharmacological effects of protocatechuic acid and its therapeutic potential in neurodegenerative diseases: review on the basis of in vitro and in vivo studies in rodents and humans," Nutritional Neuroscience, vol. 22, no. 2, pp. 72–82, 2019.

[6] R. R. A. Kalsoom Khan, N. Fatima, S. Mahmood et al., "Pharmacological activities OF protocatechuic acid," Acta Poloniae Pharmaceutica, vol. 72, no. 4, pp. 643–650, 2015.

[7] N. Bhattacharjee, T. K. Dua, R. Khanra et al., "Protocatechuic acid, a phenolic from sansevieria roxburghiana leaves, suppresses diabetic cardiomyopathy via stimulating glucose metabolism, ameliorating oxidative stress, and inhibiting inflammation," Frontiers in Pharmacology, vol. 8, Article ID 251, 2017.

[8] P. Ormazabal, B. Scazzocchio, R. Var`ı et al., "Effect of protocatechuic acid on insulin responsiveness and inflammation in visceral adipose tissue from obese individuals: possible role for PTP1B," International Journal of Obesity, vol. 42, no. 12, pp. 2012–2021, 2018.

[9] L. Zhang, Y. Ji, Z. Kang, C. Lv, and W. Jiang, "Protocatechuic aldehyde ameliorates experimental pulmonary fibrosis by modulating HMGB1/RAGE pathway," Toxicology and Applied Pharmacology, vol. 283, no. 1, pp. 50–56, 2015.

[10] Y.-T. Chang, M.-C. Chung, C.-C. Hsieh, J.-J. Shieh, and W.-J. Wu, "Evaluation of the therapeutic effects of protocatechuic aldehyde in diabetic nephropathy," Toxins, vol. 13, no. 8, p. 560, 2021.