

Supporting materials for

A Review of The Functional Activities of Chia Seed and Mechanisms of Action Related to Molecular Targets

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Table S1

Composition of chia seed and the health promoting effects

Composition	Major component	Extract method	Processing	Functional properties	Way of action
CSO	ALA ¹⁻³	cold-pressing ¹	microwave ³	anti-tumor ⁸	contributes to the expression of nuclear transcription factors ¹⁴
		heat-pressing ¹⁻²	roasting ⁶	modulate blood pressure homeostasis ⁹	normalize the operation of calcium and sodium ion channels ⁹
		enzyme assisted solvent ³	encapsulation ⁷	regulate glucose metabolism ¹⁰	adjust glycolysis ¹⁰
		microwave assisted solvent ³		immunomodulation ¹¹	contribute to proliferation of immunoglobulin E and thymocytes ¹⁵
		ultrasonic assisted solvent ⁴		reinforcement of blood lipid regulation ¹²	reduce the production of LDL and increase the content of HDL ¹⁶
		supercritical fluid ⁵		relieve metabolic syndrome ¹³	improve insulin guidance and delivery ¹⁷
		Soxhlet extraction ²			
CSM	oligosaccharides ¹⁸	water ¹⁹	delivery ²²⁻²³	moisturize intestines ²³	cholesterol-lowering ²⁸
		ion solution ²⁰		regulate blood sugar ²⁴	hypoglycemic ²⁴

		ultrasonic assist ²¹		anti-bacteria ²⁵⁻²⁷	inhibiting cell transduction ²⁹
CPI	albumin, globulin, prolamin, glutelin ³⁰⁻³²	alkali-solution & acid- isolation ³³⁻³⁴ ultra-pure water ³⁵ 1.0mol/L NaCl ³⁶ 0.2% NaOH ³³	hydrolysis ³⁷⁻⁴⁰	anti-hypertension ⁴⁰ increase satiety ⁴¹ anti-inflammatory ⁴¹ relieve atherosclerosis ⁴¹⁻⁴²	ACE activity inhibition ⁴⁰ blocking elevation of GLP-1 level caused by DPP-IV ⁴¹ 5-LOX, COX1, COX2, iNOS inhibition ⁴¹ reduces gene expression in adipogenesis ⁴¹⁻⁴²
Phenol & flavonoids	rosmarinic acid, caffeic acid, salicylic acid, flavonoids, myricetin, quercetin ⁴¹⁻⁴⁴	alkaline ⁴⁵ methanol-ethanol 70% (v/v) ⁴² mixtures of moderately polar solvents ⁴⁶⁻⁴⁷ water: acetone (1: 1) ⁴⁸ water: ethanol: acetone (1:2:3, v/v/v) ⁴⁶	concentrate	maintain homeostasis in the blood environment ⁴³ anti-oxidation ⁴¹⁻⁴³ reduce fat absorption ⁴³ DNA oxidation protection ⁴³	curbing the activity of pancreatic lipase and α -glucosidase ⁴³ free radicals (DPPH, ABTS, OH ⁻) scavenging β -carotene bleaching inhibition ⁴¹⁻⁴³ inhibitory of pancreatic lipase activity ⁴³ free radical scavenging ⁴¹⁻⁴³

Abbreviations: CSO, chia seed oil; CSM, chia seed gum, CPI, protein isolation; ALA, alpha linolenic acid; LDL, low density lipoprotein; ACE, angiotensin converting enzyme; GLP-1, glucagon peptide-1; DPP-IV, dipeptidyl peptidase IV; 5-LOX, 5-lipoxygenase; COX1, cyclooxygenase-1; COX2, cyclooxygenase-2; INOS, inducible nitric oxide synthase; DPPH, 2,2-Diphenyl-1-(2,4,6-trinitrophenyl) hydrazyl; ABTS, 2, 2'-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid);

Table S2

Micronutrients and their contents in CS

Component	Name	Content(mg/100g)	Ref.	Name	Content	Ref.
Phenolic acid	polyphenols	51.1-97.5	49-50	rosmarinic acid	92.67	50
	protocatechuic acid	74.71	50	gallic acid	1.15	50
	chlorogenic acid	0.468-23.5	49-50	caffeic acid	0.3-15.6	50-52
Flavonoid	myricetin	0.95	49, 52	quercetin	0.6-26.8	49, 52
	kaempferol	0.017-50.9	50, 52			
Isoflavone	daidzin	0.66	52	genistein	0.51	49
	genistin	0.34	52	glycerin	0.14	49
	glycitein	0.05	49			
Vitamin	vitamin A	54(IU)	52	thiamine	0.62	52
	riboflavin	0.17	49,52	nicotinic acid	8.83	52,53
	folic acid	0.049	52	ascorbic acid	1.6	52
	vitamin E	0.5-42.7	50,52			
Mineral	sodium	16-22.37	6,53	magnesium	335-403	6,49
	phosphorus	407-870	49, 53	potassium	407-870	6,49

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	iron	7.72-24.4	49, 52	cobalt	0.035	49
	copper	0.924-1.45	52	zinc	4.58-9.11	53
	selenium	0.055.2-0.078	49,52	molybdenum	0.2	6,52

Note: IU, international unit

Table S3. Amino acid sequence and the active site of CPI compositions

Origin	Amino acid sequence	Access	Pathway/substance	Biological activity	Ref.
Total protein of chia seed	YACLKVK	<i>in silico</i>	-	antibacterial	54
	KLKKNL				
	LPVFGLAEEGNVTYLH	digestion	Mmp-2, PPAR- γ , adiponectin	mediate adipocyte differentiation, relieve inflammation	41
	CNSPGPHDVALDQ	digestion	PPAR- α	prevent adipogenesis, inhibition inflammation	55
	RMVLPEYELLYE		NF- κ B		
Ribulose biphosphate Carboxylase	VPILIQIRPFPEPKQPWVDVF	SGID	DPP-4, α -glucosidase	antidiabetic activity	56-57
	VMVNVYPAIPSLPLVEVKVTIH				
	PGVGVLVVVA				
Oleosin	SPSLPLPHSHSWVDVFG				
	VKVSVTVAIAVL				
Fatty acid (F.A) desaturase 3 isoform 2	PAVPLIAIHILIRMPNPQPTPW				
	PYSFHSKVDVVFVHVKVTWVW				
	YSLPLSWSYVEVGVAVL				
F.A desaturase 3 isoform 1	PAVPLIRMPPEPNPQPTWPYSFS				
	HSKVDVKVTWVVIASPLIHIL				
	SWSYVEGVVLA				
F.A desaturase 7 isoform 1	VRINIRPFPGSHVEFVKVMVN				
	VTWVVIHILPKMPQWFSFSW				
	SYVGVTVAVLPL				
F.A desaturase 8	PAILPFPEPNSHSYVEFVKVMV				
	QVTWVVIASLVRIHINIQMPQ				
	PWSWVGPKVLSFPL				
F.A desaturase 2 isoform 2	PASPIAPPGIHPNPYSHSWDVEV				
	GVNVTWVLSFSYVKVLVQVYVA				

	PLPHVFIL
F.A desaturase 2 isoform 1	PASPIAPPGIHIQPKPQYSHSWVD VEVGVNVQVWVSLPHSFSYVKVYV APLVFVLIL
Monoacylglycerol	VAPAIQIRPKPMPTSFYSYVEVHV
Acyltransferase	KVLVTSLVRPEPLVFG
Eukaryotic translation	VPLIMIRIWPFPGHPQSHVDVFGV
Initiation factor	HVYIAPLPEIHILIQPNVLVQSLVNSK
S-adenosylmethionine	SLIHIMIRPFPHSKVMVTPAPEIAVRP
Decarboxylase	GVDVVFASFYSYVEVYILVL
Tubulin beta chain	VASLVRPLILINPTPYVHVKNVQVT VYIQIRPGSKVDVFGVEVL
Peptidyl-prolyl cis-trans	PHPKPMPTSKVDKVMVQVTI
Isomerase	AVRVEVFGVAIL
Serine threonineprotein	VAPAIAVRIHIRPGMPNVDM
Phosphatase	VQVWVYPLVEVFKVTIL
Elongation factor 1-alpha	PAVRPPLIHIMPESFSHVDVQVYV PIAPLPTSKVTVAPKVLPGVEVGK
Glyceraldehyde-3-Phosphate	PAIAVRPLIHILPEFPMSFSYSVLV
Dehydrogenase	SVTINVVHVKNVAVEVGVD
Actin	PAVPVRIHIRIWPEPGHPKVDVE VHVHVVMVWPLIMIQQSSKVAI ASLVGLIL
Clathrin adaptor complex	PPVAPAIPLINIQQFPGQSWVDV HILIMIRPTSFSYVFGVKVWVY VEVLNVVRT
α -tubulin 7 protease	VASKVDVVFHVG

FtsH protease	IAPGSHVDVEVHVLVMVNILVASKVKVT				
7S globulin	PAIPASPIASLPLIQIRIWPGPHQSYVEVK VMVNVVWRPFPTSFDVDFPEINSKVLILVA				
11S globulin	SLPLPEPFGPKPMPTPYVDVEVGVVMVQV	<i>in silico</i>		molecular docking	ACE, DPP-4 activity inhibition, renin inhibitor, antioxidation, 58
	YPAILIQIRSWSYVFPHPQVAVLVR				
	TAQEPTIRF	<i>in silico</i>		molecular docking	ACE, DPP-4 activity inhibition, antithrombosis 58
	PGLTIGDTIPNL	size exclusion	inhibit the activities of collagenase, hyaluronidase, tyrosinase		ACE, DPP-4 activity inhibition 59
	LSPNYHPNRL	chromatography		and elastase	ACE activity inhibition, regulation of glucose absorption
	LIVSPLAGRL				ACE, DPP-4 activity inhibition, glucose uptake modulation, activate proteolysis mediated by ubiquitin skin anti-aging
	IVSPLAGRL				ACE, DPP-4 activity inhibition, glucose uptake modulation, activate proteolysis mediated by ubiquitin
	APHWYTN	size exclusion	inhibit the activities of collagenase, hyaluronidase, tyrosinase		proteolysis mediated by ubiquitin 59
	DQNPRSF	chromatography		and elastase	skin anti-aging
	GDAHWAY	/		antibacterial	
	GDAHWTY				
	GDAHWVY				
	GFEWITF				
	KKLKRYYV				
	KADVPGLKK			/	antibacterial 59
	KGDVIAIR				combined with CCR2 56-60
	LKQGDVIAIR		simulated gastrointestinal digestion		antiphlogistic
	GNIFRGL				
	FQKGIQVVNHK				
	IGTPGKGIL				
	QKGDVIAIR				
	KQGDVIAIR				

-----	QKGDVIAIRA				
	KQGDVIAIR				
	DVPGLKK				
	FAFFEFELFAFFT	simulated gastrointestinal	combined with ICAM1	relieve inflammation	56-57
	LPGPPATF	digestion			

Abbreviations: Mmp-2, Matrix metalloproteinases-2; SGID, simulated gastrointestinal digestion; PPAR- γ , peroxisome proliferator activated receptor gamma; PPAR- α , peroxisome proliferator activated receptor alpha; NF- κ B, nuclear factor κ B; DPP-IV, dipeptidyl peptidase IV; ACE, angiotensin converting enzyme; CCR2, C-C motif chemokine receptor 2; ICAM, intercellular cell adhesion molecule.

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