

Characterization of *Codonopsis Radix* with Agro-product Geographical Indication products “Tanchang Dangshen” according to the analyses of elements and bioactive compounds combined with ecological factors

Supplementary Material

Table S1 Summary of the samples of radix codonopsis

No.	Cultivation region	Longitude	Latitude	Altitude (m)
TC1	Awu village, Tanchang county, Gansu	104.16413	34.291054	2393
TC2	Awu village, Tanchang county, Gansu	104.15352	34.294859	2522
TC3	Awu village, Tanchang county, Gansu	104.180008	34.270464	2287
TC4	Hadapu village, Tanchang county, Gansu	104.250482	34.27629	2281
TC5	Pangjiaxiang village, Tanchang county, Gansu	104.243726	34.275172	2281
TC6	Pangjiaxiang village, Tanchang county, Gansu	104.30442	34.27639	2260
TC7	Pangjiaxiang village, Tanchang county, Gansu	104.297728	34.289263	2260
TC8	Pangjiaxiang village, Tanchang county, Gansu	104.283316	34.279416	2247
TC9	Muer village, Tanchang county, Gansu	104.354068	34.262491	2235
TC10	Muer village, Tanchang county, Gansu	104.365303	34.24667	2341
TC11	Lichuan village, Tanchang county, Gansu	104.330279	34.264764	2223
TC12	Haoti village, Tanchang county, Gansu	104.761104	33.979566	2003
TC13	Haoti village, Tanchang county, Gansu	104.753585	33.969659	1958
TC14	Haoti village, Tanchang county, Gansu	104.742734	33.986316	2000
TC15	Hanyuan village, Tanchang county, Gansu	104.720862	33.973782	2008
TC16	Hanyuan village, Tanchang county, Gansu	104.701785	33.975369	1912
TC17	Chela village, Tanchang county, Gansu	104.515462	34.108909	2354
TC18	Chela village, Tanchang county, Gansu	104.46688	34.082006	2190
TC19	Chela village, Tanchang county, Gansu	104.446809	34.08202	2162
TC20	Jiahe village, Tanchang county, Gansu	104.379481	34.107214	1996
GS1	Sigou village, Min county, Gansu	104.050183	34.30747	2545

GS2	Dacaotan village, Zhang county, Gansu	104.228705	34.777623	2524
GS3	Sancha village, Zhang county, Gansu	104.34936	34.883009	2208
GS4	Caizi village, Longxi county, Gansu	104.406727	34.939157	2233
GS5	Caizi village, Longxi county, Gansu	104.439747	34.986647	2021
GS6	Luyuanzhen village, Weiyuan county, Gansu	104.287756	35.133375	2055
GS7	Huichuan village, Weiyuan county, Gansu	103.968827	35.146968	2361
GS8	Yujing village, Lintao county, Gansu	103.876244	35.25728	2149
GS9	Longmen village, Lintao county, Gansu	104.113388	35.358083	2349
GS10	Jishishan village, Linxia county, Gansu	102.888305	35.694569	2355
GS11	Gucheng village, Haidong county, Qinghai	102.001419	36.384477	2587
GS12	Liuquan village, Lingchuan county, Shanxi	113.436576	35.784024	545
GS13	Dongsitou village, Pingshun county, Shanxi	113.583661	36.13856	666

Table S2 Standard curves and detection limits for 13 mineral elements

	K 39	Mg 24	Fe 56	Na 23	Mn 55	Zn 64	Cu 63
Standard curves	y=0.007X	y=0.008X	y=0.091X	y=0.0022X	y=0.050X	y=0.029X	y=0.207X
R	0.9999	0.9998	0.9998	0.9999	0.9998	0.9961	0.9995
IDL (ng/mL)	32.3032	5.9849	6.0688	2.2607	0.1212	21.6611	0.3281
MDL (mg/kg)	2.6919	0.4987	0.5057	0.1883	0.0101	1.8050	0.0273
	Se 80	Ni 58	V 51	Cr 52	Mo 98	Co 59	
Standard curves	y=0.002X	y=0.176X	y=0.109X	y=0.0146X	y=0.027X	y=0.250X	
R	0.9959	0.9996	0.9999	0.9999	0.9999	0.9997	
IDL (ng/mL)	152.9660	3.8851	0.0170	0.1133	0.0170	0.0073	
MDL (mg/kg)	12.7471	0.3237	0.0014	0.00944	0.0014	0.0006	

Table S3 The soil acidity (pH), the contents of organic matter (OM), alkali-hydrolyzable nitrogen (S-N), available phosphorus (S-P) and potassium (S-K) in soil, and the contents of soil cation exchange capacity (CEC) in Tanchang District

No.	pH	OM (g/kg)	S-N (mg/kg)	S-P (mg/kg)	S-K (mg/kg)	CEC (cmol ⁽⁺⁾ /kg)
TC1	8.21	19.7	100	42.6	127	5.7
TC2	7.78	27.5	137	71.2	218	13.1
TC3	8.17	17.2	48.2	17.6	113	10.5
TC4	8.17	17.8	82.4	21.2	89	7.6
TC5	8.18	19.8	76.4	12.4	104	8
TC6	8.22	13.4	71.2	15.3	246	4.3
TC7	8.34	20.4	108	19.9	415	5.2
TC8	8.45	21.2	116	61.9	734	7.3
TC9	8.17	29.6	134	24	194	9.1
TC10	7.99	31.2	164	22	203	10.8
TC11	8.25	15.9	89.8	20.3	176	6.9
TC12	8.1	11.9	69	30.6	101	10.9
TC13	7.94	27.1	122	26.5	319	8.6
TC14	8.25	10.7	61.6	14.6	106	11.3
TC15	8.24	17.2	90.6	15.4	186	11.3
TC16	8.26	11.9	77.2	14.3	140	16
TC17	8.29	15.5	76.4	19.2	133	8.2
TC18	8.28	17.9	92	12.2	238	10.3
TC19	8.48	12.6	70.1	17.8	146	11.7
TC20	8.3	18.6	108	21	132	8.5

Table S4 The weighted regression coefficients (BW) of chemical and mineral variables of codonopsis radix produced from Tanchang District (TC) and the other geographic origin-producing areas (GS)

chemical and mineral variables	Beta Coefficients (BW)
polysaccharide	0.026268
lobetyolin	-0.04563
extractives	0.06172
Co	-0.05568
Cr	-0.0574
Cu	0.01352
Fe	-0.05445
K	0.1181
Mg	-0.11453
Mn	-0.11657
Mo	-0.11356
Ni	0.089013
Se	0.107407
Sn	-0.11735
V	-0.05552
Zn	-0.05481

Table S5 The weighted regression coefficients (BW) of climate and soil factors variables of Tanchang district to the content of K, Se, Ni, and ethanol-soluble extractive in “Tanchang Dangshen” codonopsis radix

Beta Coefficients (BW)		K	Se	Ni	ethanol-soluble extractive
BW1	Surface Soil Wetness	-0.03801	-0.04752	0.08898	0.00798
BW2	Root Zone Soil Wetness	-0.02494	-0.04293	0.07930	0.02259
BW3	Frost Days	0.050028	0.03792	-0.07327	0.02586
BW4	Precipitation Corrected	0.024941	0.04293	-0.07930	-0.02259
BW5	All Sky Surface Photosynthetically Active Radiation Total	0.04547	0.04725	-0.08936	0.00462
BW6	Annual mean Earth Skin Temperature	-0.05007	-0.03837	0.07407	-0.02527
BW7	January mean Earth Skin Temperature	-0.04853	-0.03172	0.06207	-0.03255
BW8	July mean Earth Skin Temperature	-0.04999	-0.04160	0.07982	-0.02035
BW9	east longitude	-0.05036	-0.04238	0.08125	-0.01981
BW10	north latitude	0.04675	0.01461	-0.03139	0.05491
BW11	elevation	0.036147	0.01148	-0.02460	0.04219
BW12	soil acidity	0.018167	0.07671	-0.13865	-0.08354
BW13	organic matter in soil	-0.00632	-0.08916	0.15946	0.12131
BW14	alkali-hydrolyzable nitrogen in soil	-0.01007	-0.09634	0.17268	0.12578
BW15	available phosphorus in soil	0.00456	-0.04435	0.07843	0.07295
BW16	available potassium in soil	-0.01165	-0.07799	0.14018	0.09610
BW17	soil cation exchange capacity	-0.02628	-0.00590	0.01354	-0.03428

