Analysis of the chemical composition of selected novel food supplements: benefits and risks

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In recent years, consumer's interest about the health benefits of different exotic berry-type fruits (and their corresponding juices, capsules, etc) has rapidly increased. The most extensively consumed berry-type products (commonly called superfoods) in Spain are derived from goji, pomegranate, chia, açaí, and mangosteen. All these fruits support the immune system and are nutrient dense. In general, they have a remarkable concentration of antioxidants, monounsaturated fats, dietary fibre, phytosterols, essential amino acids, and vitamins.
Although these supplements are claimed to present high levels of minerals, there are not enough scientific data to support this statement. In addition, the absence of enough data regarding the levels of toxic trace elements may represent a risk to the consumer. During the research here presented, 26 elements were quantified, and the obtained data critically discussed from the point of view of health benefits and potential risks due to the presence of toxic substances.

SAMPLE PREPARATION AND DIGESTION

Berries: they were treated with liquid nitrogen, ground, and homogenized

Capsules: the content of 10 capsules was emptied and mixed

Juices: no pre-treatment

Chia seeds: no pre-treatment

Certified reference material (SRM 3283, cranberry extract): no pre-treatment

MICROWAVE DIGESTION

0.25 g or 0.25 mL of sample + 6 mL HNO_3 + 1 mL H_2O_2

In each microwave digestion: a blank, the reference material, and 11 samples, each one by triplicate

The microwave digestion was performed increasing the temperature up to 200 ºC in 15 min and holding it at 200 ºC for 15 min. The power of the microwave oven was set at 1000 W and it was automatically adjusted by the equipment.

After cooling at room temperature, all the digestion liquors were quantitatively transferred into plastic containers and diluted to 60 mL with ultrapure water, and In was added as internal standard to yield a concentration of 5 µg L^{-1}.

After each analytical batch, the vessels were cleaned using the same microwave operating program, with 8 mL of HNO_3 and 1 mL of H_2O_2. After cooling at room temperature, all vessels were thoroughly rinsed with Milli-Q water.

METHOD VALIDATION

1) Analysis of certified reference material

Cranberry power (SRM 3283) was analyzed. The content of the following elements was certified: Ca, Cu, Fe, Mg, Mn, P, K, Na, Zn. The experimental results were compared with those provided by the manufacturer. No significant differences were observed by the student's t statistical test (P=0.05).

2) Recovery experiments

Recovery experiments were performed for the 26 target elements in goji berries and pomegranate juice, spiking the samples at concentrations between 100 ng g^{-1} and 10 mg g^{-1}. The recoveries were in the 88-109 % range, with relative standard deviations (RSDs) between 3 and 7% (n=3). The obtained recoveries confirmed that no significant metal losses occurred during the digestion procedure.

RESULTS 1 - GOJI PRODUCTS

Element	Berries	Juices[a]	Capsules	Berries mixture
Ag (µg g^{-1})	N.D. - 12	N.D.	N.D.	0.035 - 0.1
Al (µg g^{-1})	24 - 48	N.D. - 2.4	15 - 35	15 - 80
As (ng g^{-1})	N.D.	N.D.	N.D.	N.D.
Ba (ng g^{-1})	415 - 770	65 - 330	800 - 2000	6000 - 30000
Be (ng g^{-1})	N.D.	N.D.	N.D.	N.D - 35
Ca (µg g^{-1})	330 - 710	120 - 230	400 - 950	2600 - 6500
Cd (ng g^{-1})	N.D. - 90	N.D.	N.D. - 90	N.D. - 600
Co (ng g^{-1})	28 - 56	N.D.	35 - 70	150 - 350
Cr (ng g^{-1})	N.D. - 725	N.D. - 650	700 - 1500	1100 - 1300
Cu (µg g^{-1})	1.5 - 8.5	0.04 - 0.4	0.5 - 1.1	3.8 - 18.4
Fe (µg g^{-1})	35 - 72	2 - 9.3	55 - 125	85 - 130
Hg (ng g^{-1})	N.D.	N.D.	N.D.	N.D.
K (µg g^{-1})	13000 - 17000	300 - 3300	6000 - 18000	11500 - 15500
Mg (µg g^{-1})	775 - 1050	25 - 110	1100 - 1400	1500 - 3700
Mn (µg g^{-1})	6 - 12	0.2 - 1.4	4 - 6	30 - 130
Mo (ng g^{-1})	80 - 240	N.D.	70 - 175	115 - 875
Na (µg g^{-1})	3800 - 7100	30 - 380	3200 - 4300	1150 - 1300
Ni (ng g^{-1})	330 - 900	40 - 200	690 - 1260	980 - 2000
P (µg g^{-1})	1300 - 2300	30 - 490	700 - 1500	1100 - 7400
Pb (ng g^{-1})	35 - 95	N.D.	40 - 100	N.D. - 230
Sb (ng g^{-1})	N.D.	N.D.	N.D.	N.D.
Se (ng g^{-1})	N.D.	N.D.	N.D.	N.D. - 2200
Sn (ng g^{-1})	N.D. - 40	N.D.	N.D. - 40	N.D. - 40
Tl (ng g^{-1})	N.D.	N.D.	N.D.	N.D.
V (ng g^{-1})	N.D. - 250	N.D.	75-250	75 - 265
Zn (µg g^{-1})	10 - 15	N.D. - 1.6	10 - 25	12 - 60

[a] For goji juices, the results are expressed in ng/µg/mg per mL
N.D. = Not detected

RESULTS 2 – OTHER PRODUCTS

Element	Pomegranate Juice[a]	Pomegranate capsules	Chia seeds	Acaí juice[a]	Mangosteen Juice[a]
Ag (ng g^{-1})	N.D.	N.D.	N.D. - 55	N.D.	N.D. - 150
Al (µg g^{-1})	0.4 - 1.9	25 - 38	2.5 - 28	3 - 5	0.2 - 0.8
As (ng g^{-1})	N.D.	N.D.	N.D.	N.D.	N.D.
Ba (ng g^{-1})	40 - 150	750 - 1540	25000 - 50000	140 - 170	40 - 125
Be (ng g^{-1})	N.D.	N.D.	N.D.	N.D.	N.D.
Ca (µg g^{-1})	N.D. - 160	1250 - 1450	4500 - 7500	180 - 210	40 - 50
Cd (ng g^{-1})	N.D.	N.D.	N.D. - 100	N.D.	N.D.
Co (ng g^{-1})	N.D. – 30	50 - 93	270 - 800	N.D.	20 - 35
Cr (ng g^{-1})	N.D. - 650	2300 - 2800	N.D. - 650	N.D. - 650	N.D. - 650
Cu (ng g^{-1})	77 - 390	930 - 1050	3650 - 4900	55 - 160	520 - 610
Fe (µg g^{-1})	2 - 6	130 - 155	90 - 125	6 - 8	N.D. - 6
Hg (ng g^{-1})	N.D.	N.D.	N.D.	N.D.	N.D.
K (µg g^{-1})	800 - 2800	8900 - 9900	7000 - 11000	600 - 1300	600 - 900
Mg (µg g^{-1})	37 - 88	1050 - 1200	3300 - 5100	60 - 80	150 - 170
Mn (µg g^{-1})	0.4 - 1.5	6.0 - 6.4	95 - 140	3 - 4.5	1.5 - 2.5
Mo (ng g^{-1})	N.D.	320 - 430	140 - 235	N.D.	N.D.
Na (µg g^{-1})	11 - 110	3300 - 5000	N.D. - 9	40 - 90	10 - 70
Ni (ng g^{-1})	40 - 220	510 - 590	2500 - 3600	40 - 120	40 - 120
P (µg g^{-1})	55 - 170	550 - 635	4750 - 9200	150 - 190	120 - 150
Pb (ng g^{-1})	N.D. - 35	N.D. - 170	N.D. - 40	N.D.	N.D.
Sb (ng g^{-1})	N.D.	N.D.	N.D.	N.D.	N.D.
Se (ng g^{-1})	N.D.	N.D.	N.D.	N.D.	N.D.
Sn (ng g^{-1})	N.D.	N.D.	N.D.	N.D.	N.D.
Tl (ng g^{-1})	N.D.	N.D.	N.D.	N.D.	N.D.
V (ng g^{-1})	N.D.	380 - 450	N.D.	N.D.	N.D.
Zn (µg g^{-1})	0.12 - 1.1	8 - 9	49 - 75	N.D. - 0.5	1 - 1.4

LOW LEVELS OF TOXIC ELEMENTS WERE FOUND IN ALL THE ANALYZED SAMPLES

For each supplements, its **total daily contribution to the diet** was calculated taking into account the recommended dosage provided by the manufacturer and the calculated levels of minerals. The contribution of each supplement to the Recommended Daily Allowance (RDA) is shown in the next table.

Element	RDA (mg)	% RDA							
		Goji berries	Goji juice	Goji capsules	Pomegranate juice	Pomegrante capsules	Chia seeeds	Açaí juice	Mangosteen juice
Ca	800	1.2	0.8	0.1	0.5	0.2	7.2	0.5	0.3
Cu	1	13.4	0.7	0.1	1.1	0.1	4.3	0.2	2.8
Fe	14	7.9	1.2	0.9	0.9	1.3	7.9	1.0	1.5
K	2000	14.6	3.7	0.9	4.7	0.6	4.3	0.9	1.9
Mg	375	5	0.9	0.5	0.9	0.4	10.7	0.4	2.2
Mn	2	9	1.3	0.4	2.2	0.4	55	3.3	5.2
Mo	0.05	5.1	---	0.3	---	1.0	3.8	0	---
P	700	5.3	1.4	0.1	0.8	0.1	9.9	0.4	0.9
Zn	10	2.6	0.3	0.3	0.4	0.1	5.9	0.1	0.6

ONLY GOJI BERRIES AND CHIA SEEDS PROVIDE A SIGNIFICANT CONTRIBUTION TO THE DIET IN TERMS OF INORGANIC NUTRIENTS

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