Heavy Metals in Protein Supplements

GOAL

To evaluate the quality, safety, and associated health risks of commercially available protein supplements by determining the levels of protein; the heavy metals arsenic, cadmium, lead, and mercury; and 19 additional elements.

TEST APPROACH AND METHODS

We tested two or three unique samples each of 23 models of powder and ready-to-drink protein supplements. The models tested were selected from multiple retailers and purchased between November 2024 and January 2025 from supermarkets and health food stores in New York, as well as from online retailers.

The samples were transferred into brown polyethylene jars, blind-coded to preserve their identities, and shipped to an independent, accredited laboratory. At the laboratory, sample preparation or mixing was performed in fume hoods known to be free of contamination from trace metals. Water, sample containers, and other materials used for the analyses were monitored for contamination to account for any biases in sample results.

Testing for total protein was conducted using the Dumas Method. All samples were prepared and analyzed in accordance with the Association of Official Analytical Chemists Method 968.06.

Testing for total arsenic, cadmium, lead, mercury, aluminum, boron, barium, beryllium, calcium, cobalt, copper, iron, potassium, lithium, magnesium, manganese, molybdenum, sodium, nickel, strontium, thallium, vanadium, and zinc used Triple Quadrupole Inductively Coupled Plasma Cell Mass Spectrometry. All samples were prepared and analyzed in accordance with the Association of Official Analytical Chemists (AOAC) Method 2015.01.

Arsenic speciation preparation and analysis was conducted using Ion Chromatography Inductively Coupled Plasma Spectrometry. A subset of the samples showing relatively high levels of total arsenic was analyzed for the inorganic arsenic species arsenate and arsenite and three organic arsenic species—monomethylarsonic acid, dimethylarsinic acid, and trimethylarsine oxide.

Sample analysis was preceded by at least a five-point calibration curve spanning the entire concentration range of interest. Calibration curves were performed at the beginning of each analytical day and verified during analysis. The testing conformed to the quality control criteria and performance requirements set in cited official methods, as well as to those in ISO 17025.

DATA ANALYSIS AND RISK ASSESSMENT

We estimated daily consumption of the supplements using the label serving recommendations, and the associated daily intakes of protein and metals from the consumption estimates, our test results, and average body weight of U.S. adults. (In all cases, we assumed one serving per day, even where labels recommended more than one serving per day.) We used the recommended adult body weight from the Environmental Protection Agency (2011 Exposure Factors Handbook[1]) of 70 kilograms, or 154 pounds. For heavy metals test results below the method detection limit (MDL), we applied a method used by many risk assessors,[2] including the EPA,[3] to estimate the average concentration of a model. If the metal was detected in any of a model's two or three tested samples, then any of the model's samples that fell below the MDL were assumed to have a concentration of half the MDL. If the metal was not detected in any of a model's tested samples, we assumed a concentration of zero for all the samples of that model.

Health-Based Exposure Limits Informing CR's Investigation for Heavy Metals

Heavy Metal	EPA RfD, mcg/kg bw/d	OEHHA MADL, mcg/day	FDA IRL (children), mcg/day	FDA IRL (women of child-bearing age), mcg/day
Inorganic Arsenic	0.1[4]	NA	NA	NA
Cadmium	NA	4.1[5]	NA	NA
Lead	NA	0.5[6]	2.2[7]	8.8[7]

OEHHA = California Office of Environmental Health Hazard Assessment.
MADL = Maximum Allowable Dose Level.
RfD = Oral Reference Dose.
NA = Not applicable.

We compared our estimated daily intakes to health-based limits in the above table using the following equation:

% CR Level of Concern = (Estimated Daily Intake/Reference Dose or MADL) x 100

continued

[1] "Exposure Factors Handbook (2011 Edition)," Environmental Protection Agency, last modified January 15, 2025 (Link). [2] Xue, J., Zartarian, V., Wang, S., et al., "Probabilistic Modeling of Dietary Arsenic Exposure and Dose and Evaluation with 2003-2004 NHANES Data," Environmental Health Perspectives, 118, no. 3 (2010): 345-50. [3] "Regional Guidance on Handling Chemical Concentration Data Near the Detection Limit in Risk Assessments," Environmental Protection Agency, last modified August 20, 2025, (Link). [4] U.S. Environmental Protection Agency Integrated Risk Information System (IRIS) Chemical Assessment Summary, Arsenic, inorganic (Link). [5] State of California, OEHHA, Cadmium (Link). [6] State of California, OEHHA, Lead (Link). [7] Flannery, BM and Middleton, KB. Updated interim reference levels for dietary lead to support FDA's Closer to Zero action plan, Regulatory Toxicology and Pharmacology, 133 (2022) (Link).

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This equation derives from the public health concept of hazard quotient and the following equation: Hazard Quotient (HQ) = Estimated Daily Intake/Reference Dose or MADL.

A % CR Level of Concern greater than 100 or HQ greater than 1 indicates a comparatively higher health risk at this consumption level.

We used the California Office of Environmental Health Hazard Assessment (OEHHA) Maximum Allowable Dose Levels (MADL) as our benchmarks for CR's levels of concern for cadmium and lead. MADLs are levels established through California's Proposition 65 law. CR uses these values because the standards are the most protective of health. A measured level greater than 100% of CR level of concern indicates that consumption of that serving amount per day would pose a comparatively higher health risk.

However, while we use the MADLs involved in Prop 65, we approach our exposure assessment differently from what's outlined in Prop 65. Prop 65 takes into consideration consumers' average exposure over time and dietary frequency to calculate whether a product exceeds the MADL and requires a warning label. By contrast, Consumer Reports assumes the label recommended daily serving of the product in its risk assessment calculations. This difference in methodology means no Prop 65 judgments can be made from CR's findings. Our results are meant to provide guidance on which products have comparatively higher levels of lead, not to identify the point at which lead exposure will have measurable harmful health effects, or to assess compliance with California law.

Arsenic: Noncancer exposure risks were calculated by the Hazard Quotient (HQ) Method and the following equation: HQ = Exposure Dose/Reference Dose. An HQ >1 would indicate that consumption of one serving per day would pose a comparatively higher health risk. We estimated a 70-kilogram (154-pound) adult's intake of total arsenic from the tested levels in a serving of each product and compared the intake estimate to the exposure limit for inorganic arsenic.

PROTEIN AND OTHER ESSENTIAL AND NON-ESSENTIAL MINERAL ELEMENTS

We compared our estimated daily intakes of protein to the National Institutes of Health recommended dietary allowances[8] for U.S. adult males and females, and our estimated daily intake of each of the other mineral elements to the NIH adequate intake[9] and, where applicable, to the NIH tolerable upper intake level.[10]

[8] "Dietary Reference Intakes (DRIs): Recommended Dietary Allowances and Adequate Intakes, Total Water and Macronutrients," National Institutes of Health (Link). [9] "Dietary Reference Intakes (DRIs): Tolerable Upper Intake Levels, Elements," National Institutes of Health (Link). [10]"Dietary Reference Intakes (DRIs): Tolerable Upper Intake Levels, Elements," National Institutes of Health (Link).

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CR tested these 23 protein powders and shakes for arsenic, cadmium, lead, and mercury. The products are listed in alphabetical order. The values for arsenic, cadmium, and lead are given in micrograms (mcg) for one serving of the product and in parts per billion (ppb). We tested for inorganic arsenic when our test results for total arsenic exceeded our level of concern. Neither mercury nor the 19 other elements we tested for were detected at or above levels of concern in any of the products. All results are averages from the two or three lots tested for each product. NT stands for Not Tested and ND stands for Not Detected.

Product	Serving Size	Test Results									
		Arsenic, mcg	Arsenic, ppb	Total inorganic arsenic, mcg	Total inorganic arsenic, ppb	Cadmium, mcg	Cadmium, ppb	Lead, mcg	Lead, ppb	Mercury, mcg	Mercury, ppb
BSN Syntha-6 Ultra Premium Protein Matrix, Vanilla Ice Cream	47 g	0.20	4.3	NT	NT	ND	ND	0.23	4.8	ND	ND
Dymatize Super Mass Gainer, Gourmet Vanilla	333 g	2.03	6.1	2.05	6.1	ND	ND	0.12	0.4	ND	ND
Ensure Plant-Based Protein Shake, Chocolate	330 ml	0.80	2.4	NT	NT	1.55	4.7	0.65	2.0	ND	ND
Equip Prime Protein Shake, Chocolate	25.7 g	0.29	11.2	NT	NT	1.66	64.4	0.71	27.5	0.00	0.1
Garden of Life Sport Organic Plant-Based Protein, Vanilla	45 g	1.33	29.5	NT	NT	1.93	42.9	2.76	61.4	0.01	0.2
Huel Black Edition, Chocolate	90 g	1.42	15.8	NT	NT	9.21	102	6.31	70.2	0.08	0.9
Jocko Fuel Mölk Protein Shake, Chocolate	355 ml	0.57	1.6	NT	NT	1.17	3.3	0.98	2.8	ND	ND
KOS Organic Superfood Plant Protein, Vanilla	37 g	0.51	13.9	NT	NT	1.26	34.1	0.55	14.8	0.01	0.2
Momentous 100% Plant Protein, Chocolate Flavor[1]	37.7 g	1.61	42.7	1.061	28.2	1.95	51.8	2.33	61.9	ND	ND
Momentous Whey Protein Isolate, Vanilla Flavor[1]	26.5 g	0.17	6.4	NT	NT	ND	ND	0.15	5.6	ND	ND
Muscle Milk Protein Shake, Chocolate	330 ml	0.45	1.4	NT	NT	0.94	2.8	0.63	1.9	0.20	0.60
MuscleMeds Carnivor Mass, Chocolate Peanut Butter	191 g	3.58	18.8	2.41	12.6	1.67	8.8	1.21	6.3	ND	ND

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[1]Momentous told CR these products have been discontinued and are no longer commercially available. We included them in our results because protein supplements have a long shelf life and consumers may still have them in their pantries.

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Product	Serving Size	Test Results									
		Arsenic, mcg	Arsenic, ppb	Total inorganic arsenic, mcg	Total inorganic arsenic, ppb	Cadmium, mcg	Cadmium, ppb	Lead, mcg	Lead, ppb	Mercury, mcg	Mercury, ppb
MuscleTech 100% Mass Gainer, Vanilla Milkshake	357 g	1.86	5.2	1.99	5.6	ND	ND	ND	ND	ND	ND
Naked Nutrition Vegan Mass Gainer	315 g	2.41	8	1.66	5.3	3.45	11	7.70	24	ND	ND
Optimum Nutrition Gold Standard 100% Whey, Chocolate	30.5 g	0.16	5.3	NT	NT	0.24	7.8	0.27	9.0	ND	ND
Optimum Nutrition Gold Standard Protein Shake, Chocolate	325 ml	0.49	1.5	NT	NT	0.85	2.6	0.74	2.3	ND	ND
Optimum Nutrition Serious Mass, Vanilla	340 g	8.43	24.8	8.47	24.9	ND	ND	0.61	1.8	ND	ND
Orgain Organic Protein, Vanilla Bean	46 g	0.80	17.4	NT	NT	1.03	22.4	0.70	15.3	ND	ND
Owyn Plant Protein Shake, Chocolate	330 ml	0.61	1.8	NT	NT	1.97	6.0	0.43	1.3	ND	ND
Plant Fusion Complete Protein, Creamy Vanilla Bean	30 g	0.56	18.7	NT	NT	1.28	42.7	0.69	22.9	0.01	0.27
Quest Protein Shake, Chocolate	325 ml	0.50	1.5	NT	NT	1.85	5.7	0.79	2.4	ND	ND
Transparent Labs Mass Gainer, Sweet Vanilla	194 g	0.52	2.7	NT	NT	ND	ND	0.43	2.2	ND	ND
Vega Premium Sport Protein, Chocolate[2]	44 g	0.59	13.3	NT	NT	4.36	99.0	0.91	20.7	ND	ND

[2] Vega told CR the product has been renamed Vega Protein + Recovery and that the company has since changed its pea sourcing to North America.