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ARTICLES

Application of Chromatography–Mass Spectrometry Methods to the Control of Sport Nutrition and Medicines Marketed via Internet

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Abstract—Several sport nutrition products and doping drugs sold in the period from 2014 to 2016 were studied using gas and liquid chromatography coupled with mass-spectrometry. In the study, WADA-banned substances were detected in the composition of pre-workout supplements, fat burners, and prohormones. A series of selective androgen receptor modulators and peptide doping drugs were also studied. It was shown that, in some cases, preparations can be adulterated.

Keywords: doping, sport nutrition, SARM, peptide doping, ultra-high performance liquid chromatography–tandem mass spectrometry, high-resolution mass spectrometry, gas chromatography–mass spectrometry

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In recent years, the promotion of sport and healthy lifestyles is conducted as part of governmental programs. In addition to an increase in the indices of population engagement in various sport events, a shadow market of sport nutrition, supplements, and performance-enhancing drugs also increases. Such drugs often contain compounds banned by the World Anti-Doping Agency (**WADA**) [1]. To date, most of them are not included in the list of substances banned from handling in the Russian Federation and not controlled by law-enforcement authorities. Also, they should not undergo compulsory certification within the Russian Federation and there are no age restrictions for their sale.

Such products as selective androgen receptor modulators (SARM), "peptides," fat burners, pre-workout supplements, and prohormones became very popular in recent three years.

SARM form a new class of drugs marketed as an alternative to anabolic steroids. The most known representatives of this compound class are Reverol, Andarine, Ostarine, Radarine, Ibutamoren, and Miostop (Fig. 1).

Among compounds known as peptide dopings, Melanotan 2, Selank, Hexarelin, Ipamorelin, GHRP-2, and GHRP-6 (Fig. 2) gained widespread acceptance. Low effective concentrations, fast clearance, and some difficulties in the analytical identification of these compounds made them popular on the black market. It should be noted that, as for narcotic substances, certain representatives of these compound classes have been known for 5 years [2–4]. Moreover, some peptides are legally sold as medicines; however, they gained widespread acceptance and popularity as doping drugs in recent years, as they increasingly frequently come to the view of anti-doping laboratories [5–9].

For both drug classes (SARMs and peptides), sellers deny the need for additional therapy after the course of administration, which is obligatory in the use of anabolic steroids. They claim that these substances have no effect on the biological passport (in particular, the most of persons engaged in the marketing of these compounds assure that they have no effect on the steroid profile), no adverse effects, and are not identified in doping tests.

Conventional types of sport nutrition also remain to be popular and, in recent years, have been used in combination with the above-described compounds. Also, very popular substances are fat burners, pre-workout complexes, and prohormones, whose compositions differ for different manufacturers and are not

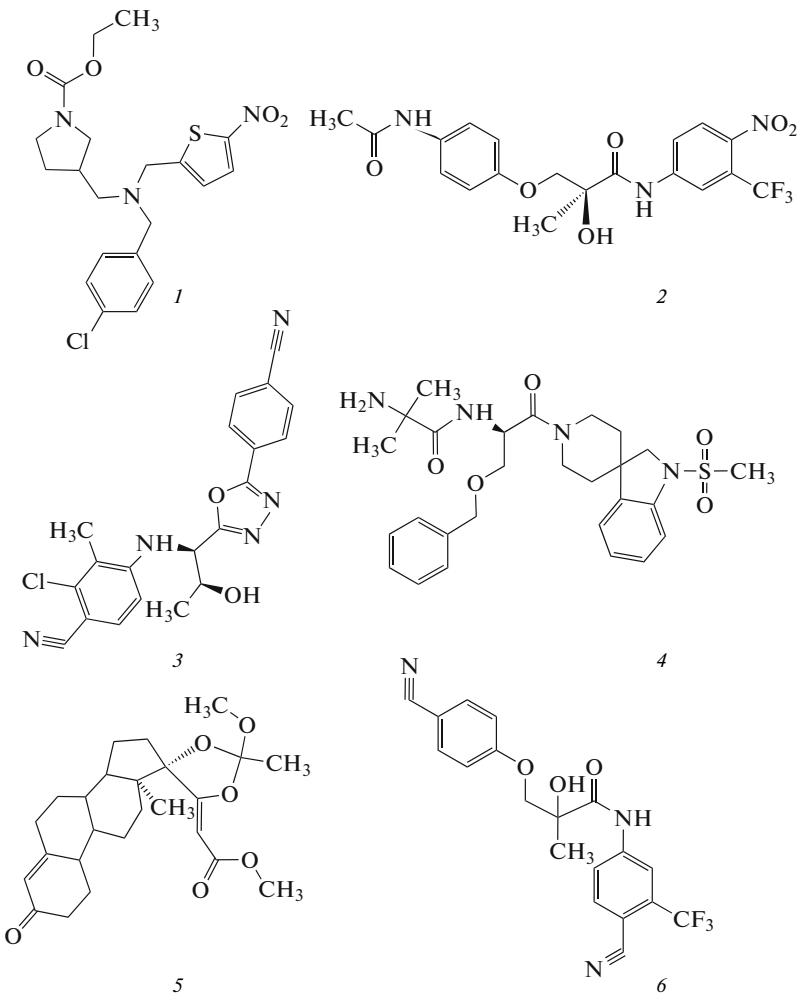

Fig. 1. Structural formulas of certain most common SARMs: (*1*) Reverol (SR9009), (*2*) Andarine, (*3*) Radarine (RAD140), (*4*) Ibutamoren, (*5*) Miostop, and (*6*) Ostarine.

a subject of certification in the Russian Federation. It is interesting that derivatives of anabolic steroids are indicated as ingredients of several prohormones banned in the Russian Federation, which, in fact, violates the current law.

The aim of the present work was to study several sport nutrition products sold in the territory of Russia from 2014 to 2016 to establish the presence of banned drugs, as well as to identify active substances in medicinal products marketed as SARMs and peptide doping by chromatography–mass spectrometry methods.

EXPERIMENTAL

Materials and methods. Samples of GHRP-2, GHRP-6, Ipamorelin, Hexarelin, Melanotan 2, Selank, DSIP, CJC-1295, HGH frag 176-191, MGF, PEG-MGF, Long-R3-IGF-1, TB-500, PT-141, Ostarine, Andarine, Ligandrol, Laxogenin, RAD-140, SR9009, Cardarine, Ibutamoren, Sarmastol, AICAR, and Miostop obtained from different batches and manufacturers, as well as samples of sport nutrition, such as APS Phenadrine (United States), Methyldrene 25 Elite (United States), EPH Hellfire (United States), APS Mesomorph (United States), San Fierce Domination (United States), Weider Super Nova caps (United States), MHP Cyclin (United States), Anavar (United States), Chosen 1 (United States), were purchased in different online stores. Deionized water (18.2 MΩ cm) was obtained on a Milli-Q Simplicity water purification system (Millipore, France). Samples and the mobile phase were prepared using the following reagents: LC-MS grade acetonitrile (Biosolve, Israel), chemically pure methanol (Vekton, Russia), analytical grade diethyl ether (Medhimprom, Russia), formic acid (98%, Acros Organics, Belgium), and analytical grade ammonia (Vekton, Russia).

The reference standards of caffeine (≥99%) and theobromine (≥98%) were purchased from Sigma-Aldrich (United States).

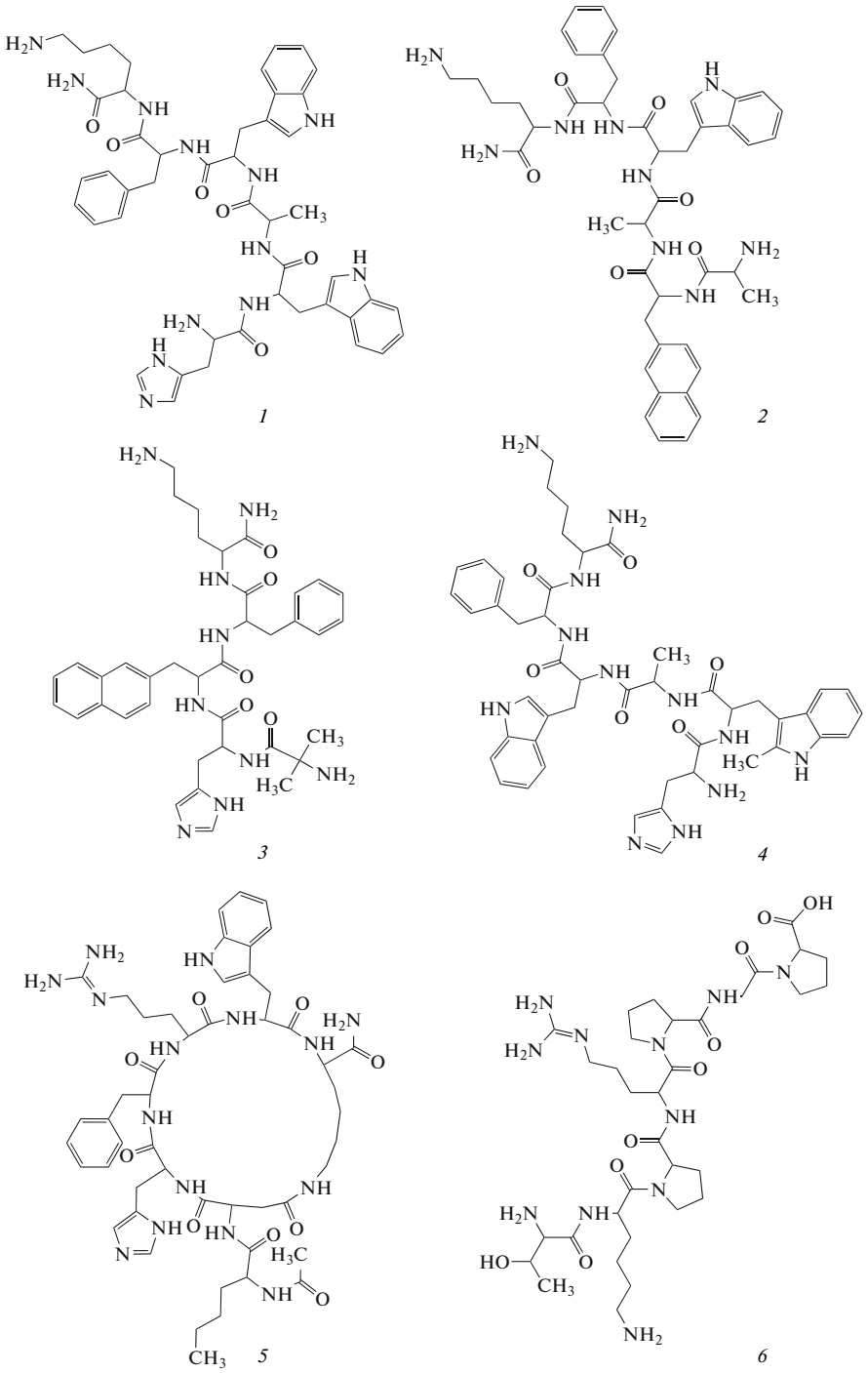

Fig. 2. Structural formulas of peptides: (*1*) GHRP-6, (*2*) GHRP-2, (*3*) Ipamorelin, (*4*) Hexarelin, (*5*) Melanotan 2, and (*6*) Selank.

Samples of ephedrine (≥90%), pseudoephedrine (≥90%), methylsynephrine (≥85%), phenylethylamine (≥95%), and phenylpropylamine (≥95%) were provided from the collection stored at the Chief Directorate of the Forensic Science Center of the Ministry of Internal Affairs for the Krasnodar region.

Table 1. Gradient elution conditions (flow rate 0.6 mL/min)

Time, min	A (acetonitrile), %	B (0.1% formic acid in water), %
0	10	90
2.5	20	80
3.5	30	70
4	50	50
5	90	10
7.5	90	10
7.8	10	90
9	10	90

Table 2. Conditions of the UHPLC–MS/ESI-MS detection of compounds

Parameter	Value
Thermo TSQ Quantum Access Max	
Evaporator temperature, °C	400
Transfer capillary temperature, °C	300
Ionization source voltage, V	4000
Ion detection mode	Positive
Spray gas flow rate, AU*	60
Axillary gas flow rate, AU	15
Target gas (argon) pressure in a collision cell, mTorr	1.5
Agilent 6540 UHD	
Evaporator temperature, °C	350
Skimmer voltage, V	65
Fragmentor voltage, V	100
Ionization source voltage, V	3500
Ion detection mode	Positive
Spraying gas flow rate, L/min	8
Axillary gas flow rate, L/min	8
Target gas (nitrogen) pressure in a collision cell, mTorr	1.5

* AU are arbitrary units.

Table 3. Temperature program in the gas chromatographic determination of compounds (carrier gas flow rate 0.8 mL/min)

Time, min	*t*, °C
0	60
3	60
12	150
20	270
30	270

The identification of selective androgen receptor modulators and growth hormone releasing peptide samples (≥95% purity) was confirmed using reference standards, whose counter synthesis was ordered at Shanghai Soyoung Biotech. Inc. (China).

Retention indices in gas chromatographic analysis were determined using the standard mixture of C_8–C_{40} hydrocarbons (Supelco, United States).

Instruments and equipment. An ultra-high performance liquid chromatography–tandem mass spectrometry (**UHPLC–MS/MS**) system was used. The system consisted of a Thermo TSQ Access Max triple-quadrupole mass spectrometric detector (Thermo Scientific, United States) with an electrospray ionization source and heating flow and a Dionex Ultimate-3000 liquid chromatograph (Thermo Scientific, United States), consisting of a degasser, a binary gradient pump, an autosampler, a column oven, and a diode array detector. Analyses by gas chromatography–mass spectrometry (**GC–MS/MS**) were performed on a system consisting of a Thermo Trace-1310 gas chromatograph (Thermo Scientific, United States) and a Thermo TSQ Quantum XLS triple-quadrupole mass spectrometric detector (Thermo Scientific, United States) with an electrospray ionization source. Data management and processing were carried out using the Thermo Xcalibur 2.2 software.

The elemental compositions of selective androgen receptor modulators and growth hormone releasing peptides were determined using an Agilent 1260 UHPLC system (Agilent Technologies, United States) coupled to an Agilent 6540 UHD high-resolution quadrupole time-of-flight mass spectrometer (Agilent Technologies, United States) with an electrospray ionization source.

Substances were separated on an UHPLC on a Phenomenex Kinetex C18 column (100 m × 2.1 mm, 1.7 μm) and by GC on a Phenomenex Zebron ZB-1MS column (30 m × 0.25 mm × 0.25 μm).

The conditions of separation and detection are given in Tables 1–4.

RESULTS AND DISCUSSION

The samples of peptides, SARMs, and sport nutrition were bought in the period from 2014 to 2016 in different online stores in order to provide a more representative sampling. A wide variety of sport nutrition products and their quite rapid rotation on the market necessitated the limitation of the list of studied products by the names being most popular at the time of study. It was noted in the test purchase that AICAR and Cardarine (GW1516), being peroxisome proliferator-activated receptor (PPARδ) agonists, were sold in different stores as both peptides and SARMs despite the fact that these substances can be assigned to these compound classes neither structurally nor by their effects.

Samples for UHPLC were prepared by dissolving a portion of a studied sample in a 0.1% solution of formic acid in water (for peptides) or methanol to obtain a solution with a concentration of 100 nm/mL. The SARM samples were dissolved in a water–acetonitrile mixture (50 : 50, v/v). In the gas chromatographic analysis of fat burners containing plant raw materials (Methyldrene 25 Elite, EPH Hellfire, and Weider Super Nova caps), the samples were heated in water for 30 min at 45°C with adding ammonia to pH 9 followed by liquid–liquid extraction with diethyl ether. The resulting extract was analyzed under the above conditions in the total ion current scan mode. The result was recognized as positive, the retention parameters of a detected substance and its reference standard if in the study differed by no more than 0.1 min and the mass spectra were identical. To unify the considered approach and facilitate its extension to other gas chromatographic systems, it also seemed reasonable to apply retention indices, which were determined using the standard mixture of *n*-alkanes analyzed under the same conditions as the samples under study.

The data obtained were confirmed by UHPLC–MS/MS with similar sample preparation except for the step of back extraction.

The data from the study of several fat burners, preworkout complexes, and prohormones are summarized in Table 5.

Despite the fact that Anavar and Chosen 1 were claimed to contain a mixture of dihydroepiandrosterone esters, only dehydroepiandrosterone was detected in the composition of these products and identified by comparing the retention indices and the obtained spectrum with the library data (NIST'14).

As is seen from the data given, most of fat burners and preworkout complexes contain two purine-series alkaloids: caffeine and theobromine which are responsible for the stimulatory effect. Ephedrine and methylsynephrine included in the list of banned drugs were also found in some fat burners. The main difficulty in the gas chromatographic determination of ephedrine consists in the fact that its retention parameters and mass spectrum are identical to those of pseudoephedrine. For this reason, it was identified using a confirmatory method, UHPLC–MS/MS, which provides efficient separation of ephedrine and pseudoephedrine. It should be noted that, in none of the products, the presence of ephedrine was claimed directly; only "ephedra extract" was indicated to avoid difficulties in declaring, reporting, and entry of products into some countries.

The next step was the identification of compounds sold as SARMs and peptide doping. Primary studies were performed using low-resolution UHPLC–MS/MS and elemental composition was determined by high-resolution mass spectrometry. The obtained findings in combination with the data for substances under study [2–10] provided a basis for the selection of structures that were synthesized afterwards.

Table 4. Conditions for the GC–MS/MS detection of substances

Parameter	Value
Ionization source temperature, °C	220
Transfer line temperature, °C	270
Injector temperature, °C	270
Injection volume, μL	1
Split ratio	1 : 10
Carrier gas	Helium
Scan mode	Total ion current (TIC) scan by the first quadrupole (Q1)
Scan range, Da	40–450
Emission current, μA	50

The data from the study of SARMs and PPARδ agonists (AICAR and GW1516) are given in Table 6. To calculate the accuracy of mass determination, the possibility of the formation of adducts and fragmentation of the starting substances in the source was considered. Table 6 gives the theoretical monoisotopic weights of the studied substances from which theoretical ion masses were calculated and compared with the recorded *m/z* values; the difference between them was used to calculate the accuracy of mass determination.

For compounds that can be determined in both positive and negative ion detection modes, characteristic MRM transitions are given for both versions.

Note that GC–MS could not be used as a confirmatory method, as these compounds, except for the

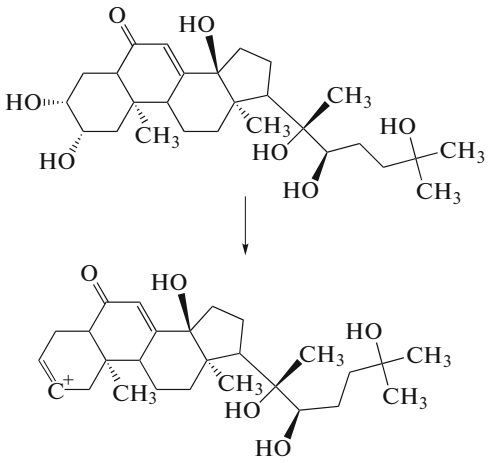

Fig. 3. Fragmentation of 20-hydroxyecdysone upon electrospray ionization.

Table 5. Data from the study of fat burners, preworkout complexes, and prohormones

Detected substance	Retention index (GC–MS)	Detected ions at a collision energy of 25 eV, relative intensity (UHPLC–MS/MS-ESI)	Name								
			APS Phenadrine	Methyldrene 25 Elite	Hellfire	APS Mesomorph	San Fierce Domination	Weider Super Nova caps	MHP Cyclin	Anavar	Chosen 1
Ephedrine	1350	166.1 → 148.0 (100) 166.1 → 117.1 (50) 166.1 → 133.0 (25)	–	+	+	–	–	–	–	–	–
Methylsynephrine	1610	182.0 → 105.0 (100) 182.0 → 149.1 (60) 182.0 → 133.0 (35)	–	+	+	–	–	–	–	–	–
Caffeine	1805	195.0 → 138.1 (100) 195.0 → 110.0 (65) 195.0 → 83 (40)	+	+	+	+	+	+	+	–	–
Theobromine	1912	181.1 → 138 (100) 181.1 → 110.0 (70) 181.1 → 83 (60)	–	+	+	+	+	+	–	–	–
Phenylethylamine	1130	122.1 → 105.0 (100) 122.1 → 77.0 (55)	+	–	–	–	–	–	–	–	–
Phenylpropanolamine	1330	152.1 → 117.0 (100) 152.1 → 134.0 (50)	+	–	–	–	–	–	–	–	–
Dehydroepiandrosterone (DHEA)	2480	–	–	–	–	–	–	–	–	+	+

Table 6. Data from the studies of several SARMs and PPARδ agonists

Claimed substance	QTOF					QqQ			
	molecular formula	theoretical monoisotopic mass, Da	detected *m/z*	detected ion	mass accuracy, Δ ppm	retention time, min	polarity, MRM transitions (*m/z*), collision energies (eV)	relative intensity of the product ion, %	extracting lens voltage, V
Andarine (S-4)	$C_{19}H_{18}F_3N_3O_6$	441.1148	442.1201	$[M + H]^+$	4.5	3.22	(+): 442.1 → 108.1 (32) 442.1 → 148.0 (29) 442.1 → 190.0 (23) (–):440.0 → 204.9 (31) 440.0 → 150 (23) 440.0 → 260.9	100 80 68 100 95 85	101 63
Ostarine (MK-2866)	$C_{19}H_{14}F_3N_3O_3$	389.0987	390.1049	$[M + H]^+$	2.8	3.53	(+): 389.1 → 120.1 (29) 389.1 → 193 (30) 389.1 → 187 (14) (–): 388.0 → 118.0 (40) 388.0 → 268.9 (21) 388.0 → 185 (40)	100 80 60 100 20 18	90 46
Cardarine (GW1516)	$C_{21}H_{18}F_3NO_3S_2$	453.0680	454.0733	$[M + H]^+$	4.4	7.89	(+): 454.0 → 257.0 (28) 454.0 → 255.9 (46) 454.0 → 188.0 (43)	100 20 20	90
Ligandrol (LGD-4033)	$C_{14}H_{12}F_6N_2O$	338.0854	339.0918	$[M + H]^+$	2.7	4.30	(+): 339.1 → 199.0 (28) 339.1 → 220 (27) 339.1 → 240 (24)	100 85 45	88
Laxogenin	$C_{27}H_{42}O_4$	430.3083	**445.2948**	–	–	**6.70**	**(+): 445.3 → 191.0 (19)** **445.3 → 145.0 (36)** **445.3 → 283.0 (18)**	**100** **42** **18**	**65**
Radarine (RAD140)	$C_{20}H_{16}ClN_5O_2$	393.0993	394.1052	$[M + H]^+$	3.6	3.35	(+):394.0 → 223 (13) 394.0 → 170 (30) 394.0 → 205 (22)	100 55 40	82
AICAR (A9788)	$C_9H_{15}N_4O_8P$	258.0964	259.1034	$[M + H]^+$	1.2	0.56	(+): 259.1 → 110.1 (24) 259.1 → 127.1 (11)	100 75	48
Reverol (SR9009)	$C_{20}H_{24}ClN_3O_4S$	437.1176	438.1226	$[M + H]^+$	5.2	6.51	(+): 438.1 → 125.0 (30) 438.1 → 89.2 (80)	100 10	56
Miostop (YK-11)	$C_{25}H_{34}O_6$	430.2355	399.2154	$[M\text{-}OCH_3]^+$	4.3	6.48	(+):399.2 → 325.1 (16) 399.2 → 357.1 (10) 399.2 → 307.1 (28)	100 40 30	57
Ibutamoren (MK-677)	$C_{27}H_{36}N_4O_5S$	528.2406	529.2462	$[M + H]^+$	3.2	2.55	529.2 → 267.1 (19) 529.2 → 263.0 (15) 529.2 → 235.0 (22)	100 45 35	77
Sarmastol (AC-262, 356)	$C_{18}H_{18}N_2O$	278.1419	279.1496	$[M + H]^+$	–1.4	4.39	(+): 279.1 → 193.1 (36) 279.1 → 169.1 (23) 279.1 → 195.1 (24)	100 75 80	55

Table 7. Data from the study of several peptides

Claimed substance	QTOF					QqQ			
	formula	theoretical monoisotopic mass, Da	detected *m/z*	detected ion	mass accuracy, Δ ppm	retention time, min	polarity, MRM transitions (*m/z*), collision energies, eV	relative intensity of the product ion, %	extracting lens voltage, V
Ipamorelin	Aib-His-(D-β-Nal)-(D-Phe)-Lys-NH_2	711.3850	356.7006	$[M + 2H]^{2+}$	−2.2	3.00	(+): 356.7 → 129.0 (20) 356.7 → 222.9 (20) 356.7 → 110 (30)	100 60 50	40
Hexarelin	H-His-D-Trp(2-Me)-Ala-Trp-D-Phe-Lys-NH_2	886.4602	444.2369	$[M + 2H]^{2+}$	1.1	3.22	(+): 444.2 → 129.1 (20) 444.2 → 84.2 (33) 444.2 → 110.1 (32)	100 65 45	42
Selank	H-Thr-Lys-Pro-Arg-Pro-Gly-Pro-OH	751.4341	376.7239	$[M + 2H]^{2+}$	1.2	0.95	(+): 376.7 → 129.1 (20) 376.7 → 84.2 (30) 376.7 → 254.1 (23)	100 75 20	41
DSIP	L-Trp-L-Ala-Gly-Gly-L-a-Asp-L-Ala-L-Ser-Gly-L-Glu-OH	848.3301	425.1706	$[M + 2H]^{2+}$	4.1	0.85	(+): 848.5 → 229.8 (45) 848.5 → 300.7 (34) 848.5 → 592.0 (26)	100 65 50	101
MGF-PEG	YQPPSTNKNTKSQRRKGSTFEERK-PEG	2866.4786 + PEG	478.7561	–	–	–	–	–	–
CJC-1295	YADAIFTQSYRKVLAQL-SARKLLQDILSR-NH_2	3367.9046	842.9753	$[M + 4H]^{4+}$	9.7	3.54	(+): 842.5 → 136.0 (39) 842.5 → 206.8 (45) 842.5 → 349.9 (35)	100 30 18	65
Melanotan 2	Ac-Nle-c[Asp-His-DPhe-Arg-Trp-Lys]-NH_2	1023.5403	512.7763	$[M + 2H]^{2+}$	2.3	3.46	(+): 512.8 → 435 (20) 512.8 → 110.1 (40) 512.8 → 158.9 (38)	100 80 40	48
TB-500	(Acetyl)Leu-Lys-Lys-Thr-Glu-Thr-Gln	**4921.4158**	**828.2583**	–	–	3.08	(+) 828.2 → 129.1 (49) 828.2 → 240 (44) 828.2 → 212.9 (47)	100 35 28	48
PT-141	Ac-Nle-cyclo(Asp-His-D-Phe-Arg-Trp-Lys-OH)	1024.5243	513.2684	$[M + 2H]^{2+}$	2.1	3.26	(+): 513.2 → 86.2 (31) 513.2 → 435.7 (19) 513.2 → 110.1 (29)	100 92 85	58
Long-R3-IGF-1	MFPAMPLSSLFVNGPRTL-CGAELVDA LQFVCGDRGFYFNKPTGYGSSSRRAPQT-GIVDECCFRSCDLRRLEMYCAPLKPAKSA	9111.4531	–	–	–	–	–	–	–
HGH frag 176-191	YLRIVQCRSVEGSCGF	1815.8760	908.9431	$[M + 2H]^{2+}$	2.4	3.23	(+): 908.9 → 136.0 (53) 908.9 → 249.0 (51) 908.9 → 253.0 (56)	100 65 30	93
GHRP-2	1. Ala-beta-Nal-Ala-Trp-Phe-Lys-NH_2	817.4275	409.7207	$[M + 2H]^{2+}$	0.9	3.60	(+): 409.5 → 170.0 (30) 409.5 → 240.9 (22) 409.5 → 129.0 (20)	100 65 60	42
GHRP-6	His-Trp-Ala-Trp-Phe-Lys-NH_2	872.4446	437.2293	$[M + 2H]^{2+}$	0.7	3.20	(+): 436.9 → 129.0 (20) 436.9 → 247.9 (30) 436.9 → 158.9 (30)	100 70 65	43

TMS derivative of AICAR, are low volatile and thermally unstable.

It is seen from the data presented that, in the case of Laxogenin, the claimed and detected substances are different (bolded in Table 6). It is likely that, in this case, 20-hydroxyecdysone earlier used in professional sports was used as the active substance. Its ionization is accompanied by the elimination of two hydroxyl groups in 1 and 2 positions (Fig. 3), the second group being eliminated with a proton attachment to form a multiple bond. In this case, the monoisotopic ion mass is 445.2949 Da, which agrees well with the data obtained.

The analysis of peptide-nature compounds is complicated by the fact that they are sensitive to temperature storage and transportation conditions, which are almost never observed in online shopping.

As for other products under consideration, the studied peptides have different mechanisms of action on a body. In a first quite rough approximation, they can be divided into groups as follows: (1) growth hormone fragment having a lipolytic effect; (2) growth hormone releasing peptides stimulating the production of growth hormone; and (3) peptides favoring body restoration (for example, in the case of MGF peptide restoration occurs due to activation of muscle stem satellite cells [6]). The data from the study of peptides are given in Table 7. Analyzing the resulting data, one can draw the following conclusions: in some cases, the active substance is either absent at all (Long-R3-IGF-1) or inconsistent with the claimed one (MGF-PEG). It is seen from the data given that, as in [10], the TB-500 peptide sample is a fragment of the Thymosin beta-4 protein acylated at the N-terminus of its polypeptide chain (bolded in Table 7).

Since the diode array detector was also used in the study in addition to the mass spectrometric one, it was interesting to estimate the purity of samples by the presence of impurity peaks. In the case of SARM, the ready-to-use dosage form typically contained magnesium stearate and talc, while the peptide-nature drugs showed intense peaks of other extraneous agents (observed in UV-vis detection and absent in total ion current chromatograms when the mass spectrometric detector was used), which puts in doubt the declared 98% purity of the sample.

CONCLUSIONS

In the study of several online marketed sport nutrition products and drugs for the conformity with the claimed composition and for the presence of banned substances therein, we found and showed inconsistencies between the claimed and actual compositions (including "empty products"). Products containing ephedrine, DHEA, and methylsynephrine which are subjects of control of law enforcement authorities and included in the list of drugs banned by WADA were found; the label having no indication of their possible presence in the product composition. The presence of impurity substances in the composition of some peptides was noted.

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REFERENCES

1. World Anti-Doping Agency (WADA), The 2017 Prohibited list International Standards. www.wada-ama.org/sites/default/files/resources/files/wada-2016-prohibited-list-en.pdf. Accessed January 8, 2017.
2. Nath, N., Giri, S., Prasad, R., Salem, M.L., Singh, A.K., and Singh, I., *J. Immunol.*, 2005, vol. 175, p. 566.
3. Baba, M., Ohmura, M., Kishi, N., Okada, Y., Shibata, S., Peng, J., Yao, S., Nishino, H., and Okuyama, T., *Biol. Pharm. Bull.*, 2000, vol. 23 P, p. 660.
4. Thevis, M., Thomas, A., Fubholler, G., Beuck, S., Geyer, H., and Schanzer, W., *Rapid Commun. Mass Spectrom.*, 2010, vol. 24, p. 2245.
5. Thevis, M., Thomas, A., and Schanzer, W., *Forensic Sci. Int.*, 2011, vol. 213, p. 35.
6. Esposito, S., Deventer, K., and Van Eenoo, P., *Rapid Commun. Mass Spectrom.*, 2012, vol. 26, p. 686.
7. Thevis, M., Thomas, A., Geyer, H., and Schanzer, W., *Growth Horm. IGF Res.*, 2012, vol. 24, p. 276.
8. Semenistaya, E., Zvereva, I., Krotov, G., and Rodchenkov, G., *Drug Test. Anal.*, 2016, vol. 8, p. 940.
9. Mazzarino, M., Calvaresi, V., de la Torre, X., Parrotta, G., Sebastianelli, C., and Botre, F., *Forensic Toxicol.*, 2015, vol. 33, p. 321.
10. Zvereva, I., Semenistaya, E., Krotov, G., and Rodchenkov, G., *Analitika*, 2014, vol. 3, p. 58.

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