

TECHNICAL NOTE

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Black Market in Anabolic Steroids—Analysis of Illegally Distributed Products

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ABSTRACT: Anabolic steroids found in the illegal market often do not contain ingredients declared on the label. Forty-two products encountered in the illegal distribution channels were analyzed by gas chromatography/mass spectrometry. Fifteen of the products did not contain the expected ingredients. Mainly, counterfeits of parabolon and primobolan products were found. Instead of trenbolone or metenolone, the cheaper agents nandrolone or testosterone derivatives were identified. In one product the gestagene progesterone was found. In two other cases no steroid was present or tocopherole was substituted.

KEYWORDS: forensic science, substance abuse, chemistry, anabolic steroids, black market, gas chromatography—mass spectrometry

In 1976, steroids were added to the list of doping agents banned by the International Olympic Committee (IOC). Nevertheless, steroid use among athletes appears to be increasing rather than decreasing. There are estimates that more than one million Americans are taking anabolic steroids including many male and female athletes of all age groups, from the mature professional athlete to the student in puberty. Since steroids must be prescribed, a black market has developed due to the increasing popularity of bodybuilding (1,2).

Due to the limited availability of approved products, a black market for anabolic steroids has appeared in Germany, especially after the opening of the East European borders. Reports of counterfeit products having substituted or omitted ingredients accumulate. Even many “anabolica dealers” do not know whether their products are authentic or counterfeit. In addition to the black market of anabolic steroids, special books are available, which intend to be a guideline for the taking of steroids and provide information about their effects, prices on the black market, and known counterfeits.

Many gas chromatographic—mass spectrometric (GC/MS)

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methods have been established for the determination of steroids either qualitatively or quantitatively (3–8). The steroids are extensively metabolized. Therefore, in the common doping analysis conjugated and free anabolic steroids were determined in urine samples. The common procedures involve the analysis of silyl or methoxime-silyl derivatives. According to Walters et al. (9) we describe the analysis of tablets, aqueous suspensions and oil-based injectables of different anabolic steroids found in the illegal market in Germany. Chemical structures of steroids described in this paper are displayed in Fig. 1.

Material and Methods

Reagents and Equipment

Methanol (Uvasol, Merck, Darmstadt), water (HPLC grade, Merck). Hewlett-Packard 5890 Series II Gas chromatograph with fused silica capillary column HP-5MS (30 m × 0.25 mm ID, df = 0.25 μm); HP 5972 Series Mass Selective Detector—Temperature program: 100°C for 2 min, 30°C/min up to 290°C held for 25 min; split-splitless injector at 270°C. Steroid standard solutions, dissolved in methanol (1 mg/L), were obtained using the following pure powders, or as original products and prepared as described below:

metenolone acetate, trenbolone acetate and drostanolone propionate

boldenone undecylenate
4-chlordehydromethyltestosterone
nandrolone decanoate; testosterone propionate; testosterone phenylpropionate; testosterone isocaproate; testosterone decanoate
metandienone
testosterone enantate
oxandrolone
oxymetholone
nandrolone undecanoate
stanozolol

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FarmAnimal, ARG
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Polfa, PL
Schering, GER
SPA, I
Syntex, GB
Theramex, F
Zambon, E

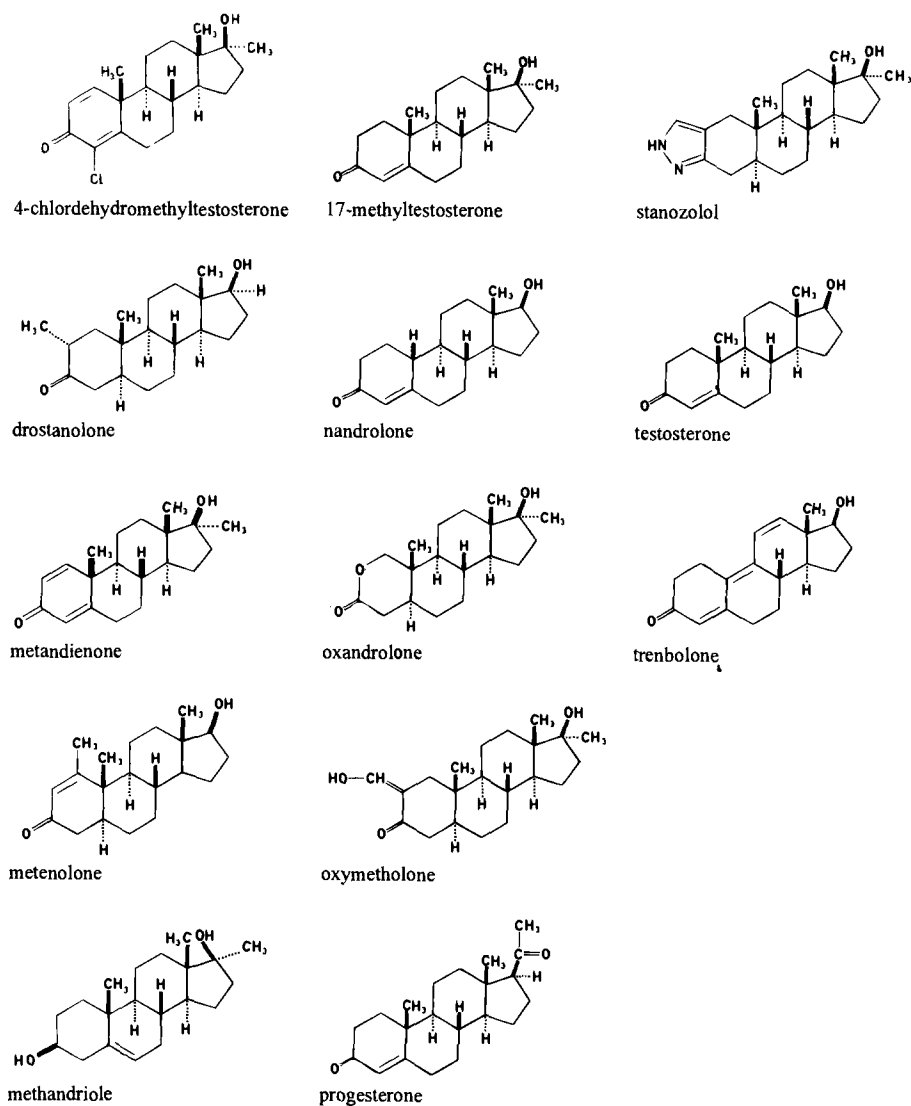


FIG. 1—Structures of analyzed anabolic steroids.

Sample Preparation

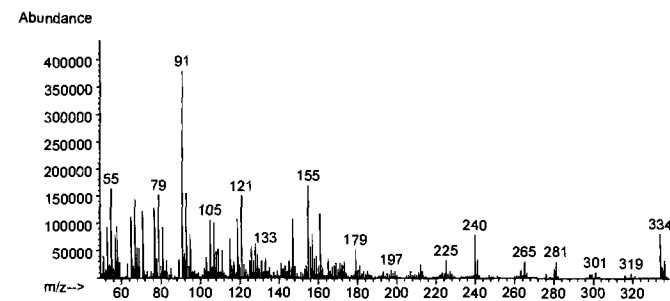
Oils and aqueous suspensions: To 0.1 mL oil or suspension, 2 mL of a solution from methanol/water (10:1) were added. After shaking and centrifugation (5 min; 10,000 g), the clear supernatant layer was used for a GC/MS analysis. Tablets: To a finely ground sample (1 tablet) 10 mL of methanol were added. These suspensions were sonicated for 10 min and after centrifugation (5 min; 10,000 g) the clear supernatant layer was used for a GC/MS analysis.

Results

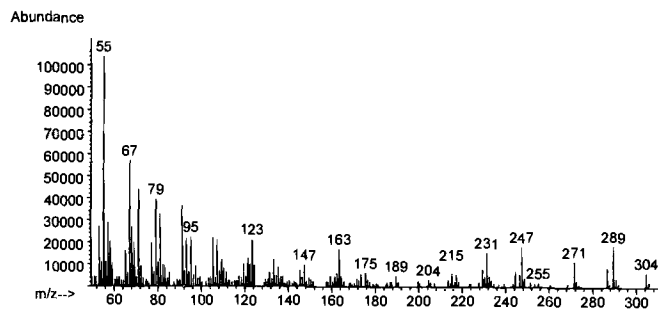
In the described sample preparation, the detection and identification of the active ingredients in the illicit products are simple and rapid, and require only a small amount of material. The most common dosage forms for anabolic steroids are oil-based injectables and tablets. An identification of anabolic steroid esters is possible without splitting or derivatization. Capillary GC has the ability to chromatograph the majority of the steroids at high temperature. We found no noteworthy contamination by traces of oil. Besides oxymetholone, an artefact suggested by the reaction of the steroid and methanol was detected (7). In Fig. 2, the mass

spectra of all analysed steroid esters are shown. Corresponding mass spectra were compared with results generated by analysis of the steroid standards.

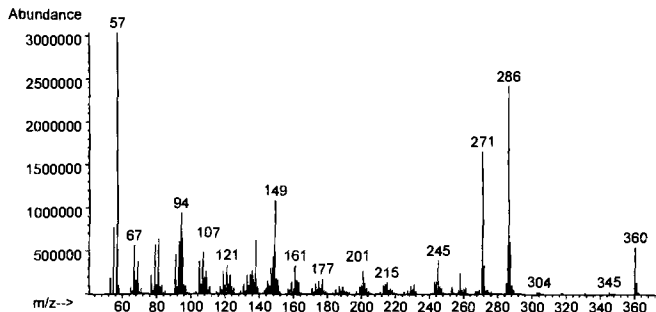
The results of analysis for typical anabolic steroid products encountered on the German black market are summarized in Table 1. There is a variety of brand names, some of which have no relationship to the ingredients in the products, and others are counterfeits imitating products. Identical labels and lot numbers give no assurance that the same active ingredients are present. Analysis of 42 products including 5 unlabeled samples (or entitled with pseudo names), resulted in 15 counterfeits. Typical examples of counterfeit products are parabolon and primobolan injectables. None of 4 parabolon and 4 primobolan samples contained the original ingredients trenbolone or metenolone, respectively. Identified ingredients were testosterone esters, 17-methyltestosterone and nandrolone. In one product progesterone was identified, in two other samples no steroids were found. One of them, however, contained tocopherole. Other proven counterfeits consisted of masteron with methandriol dipropionate, nandrolone decanoate instead of drostanolone, and some testosterone products with nandrolone instead of testosterone esters. Investigated oral steroid products contained oxandrolone, oxymetholone and metandienone. In 2



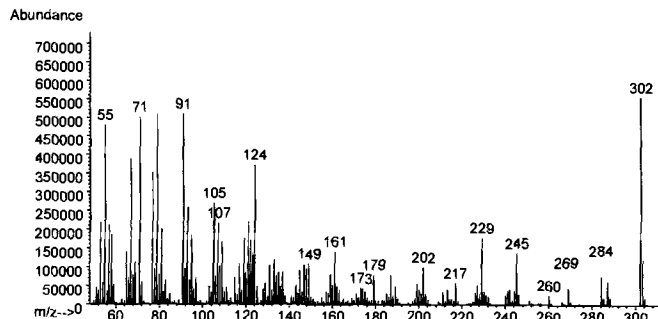
4-chlorodehydromethyltestosterone



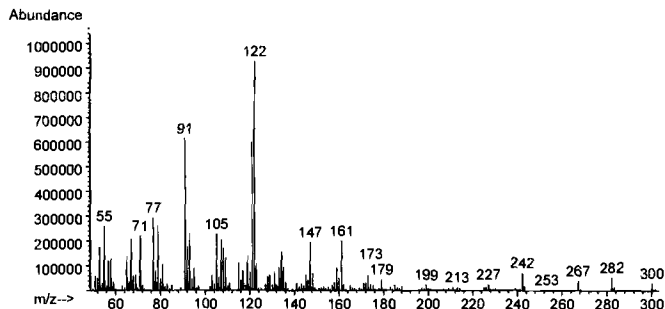
methandrolole dipropionate



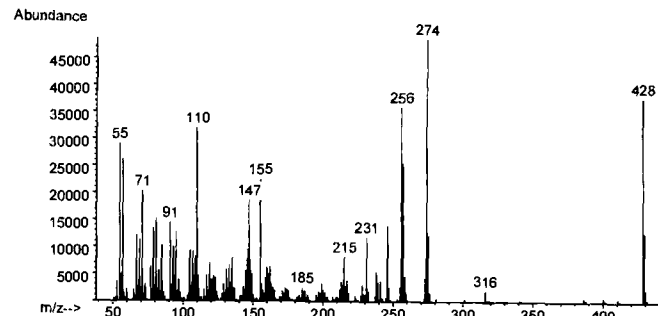
drostanolone propionate



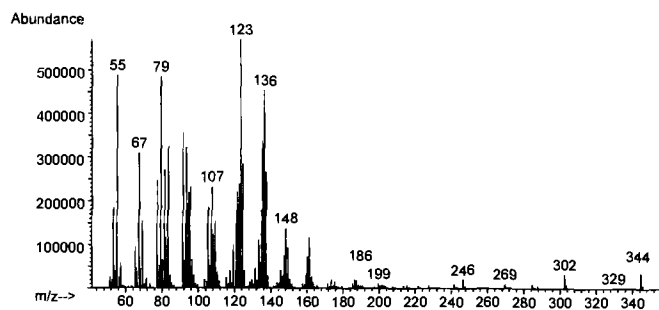
17-methyltestosterone



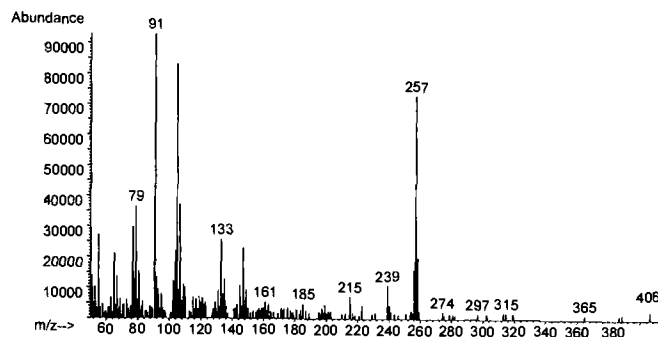
metandienone



nandrolone decanoate

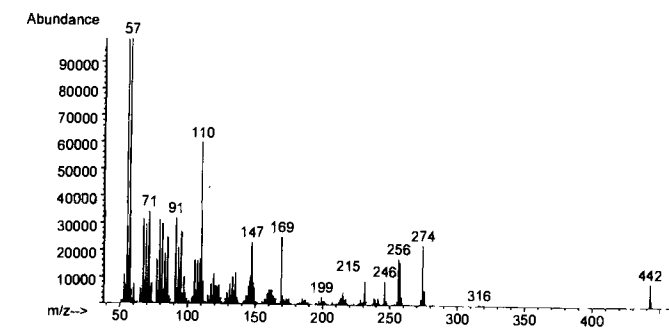


metenolone acetate

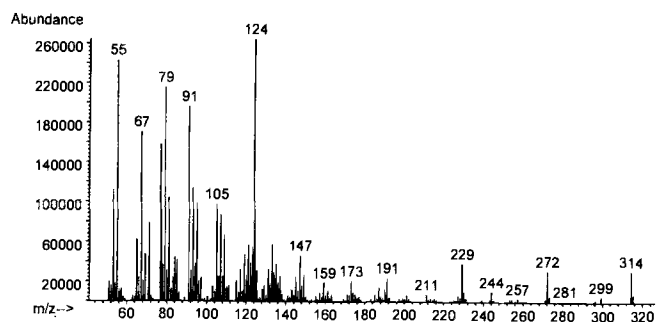


nandrolone phenylpropionate

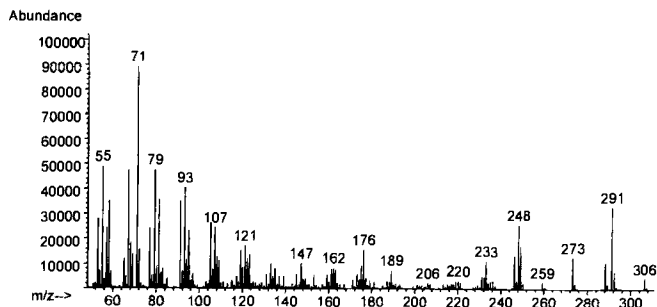
FIG. 2—Mass spectra of analyzed anabolic steroid esters.



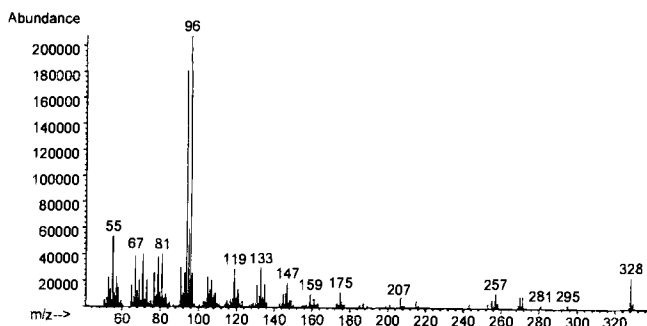
nandrolone undecanoate



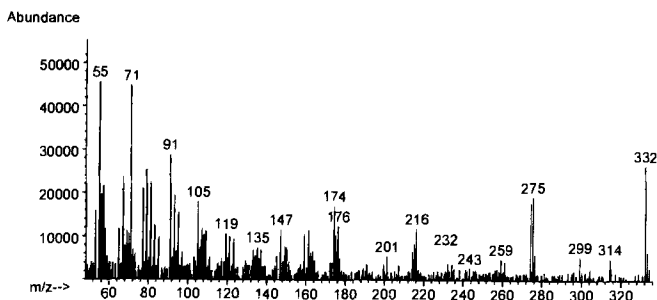
progesterone



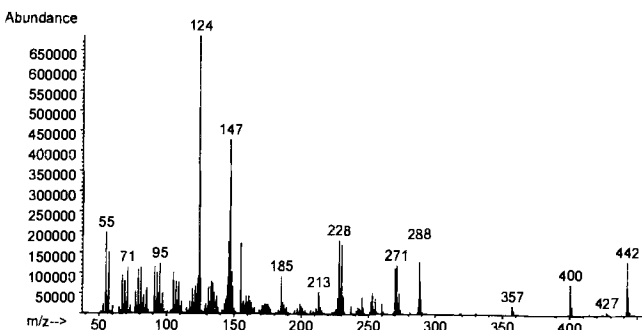
oxandrolone



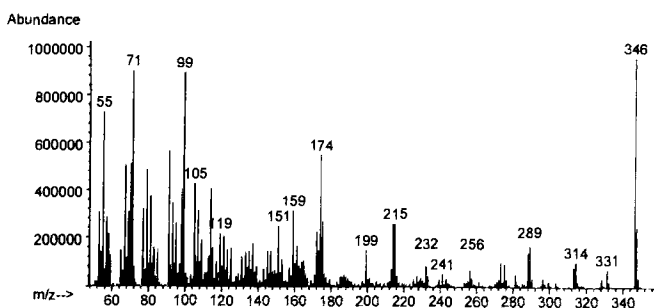
stanozolol



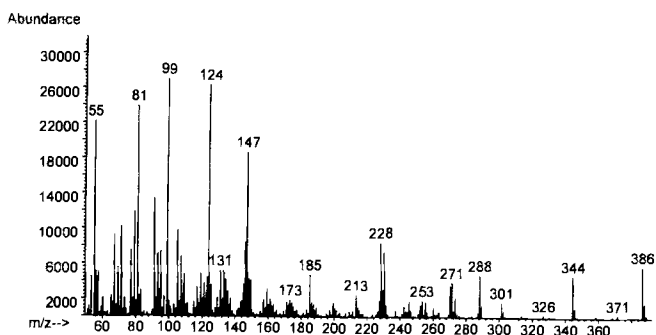
oxymetholone



testosterone decanoate



oxymetholone artefact with methanol



testosterone isocaproate

FIG. 2—Continued.

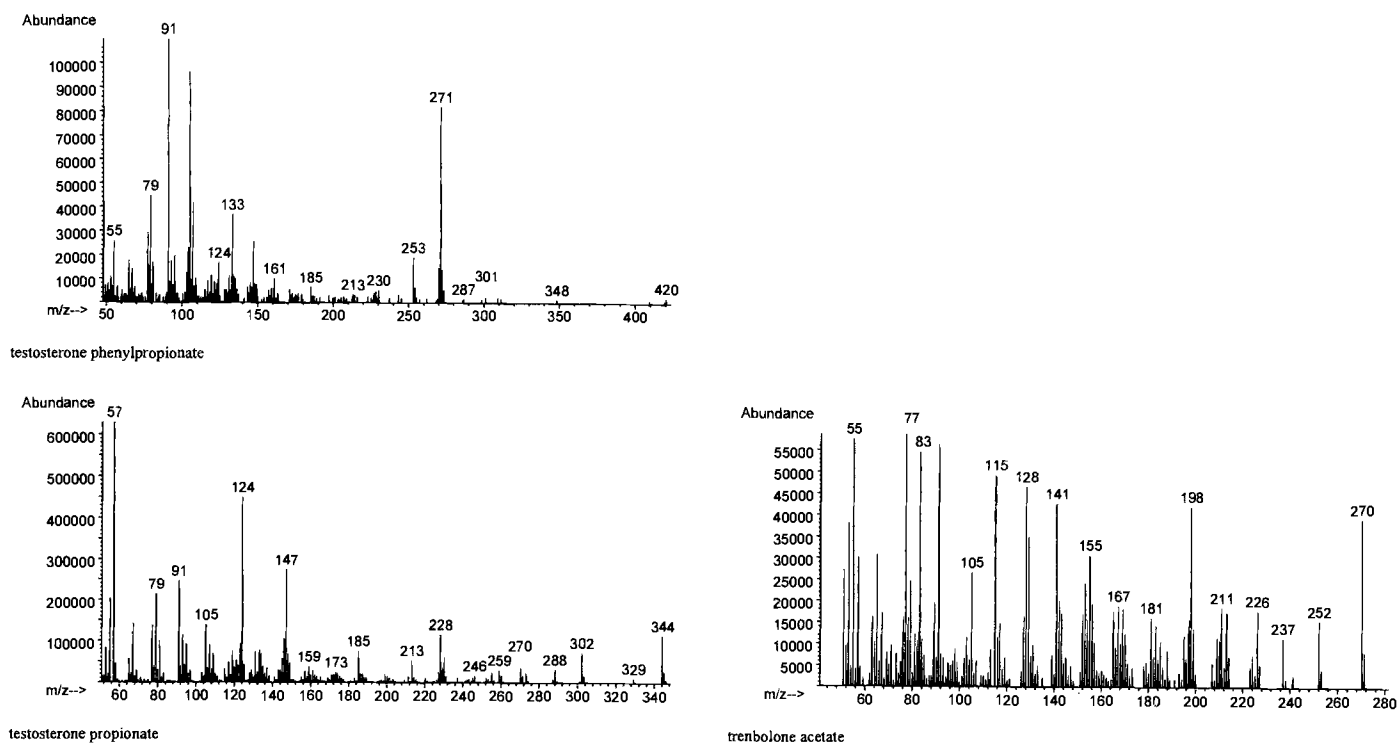


FIG. 2—Continued.

TABLE 1—Results of analysis of steroid products found in the illegal market

Product labeling	Expected Ingredient(s)	Identified Ingredient(s)
Injectables		
Boldenone		
<i>Boldefarm</i> —50 mL oil-based injection (5 g/100 mL); Farm Animal (Argentina)	boldenone undecylenate	boldenone undecylenate
Drostanolone		
<i>Masteron</i> —2 mL oil-based injection, Drostanolonum 100 mg Syntex	drostanolone propionate	drostanolone propionate
<i>Masteron</i> —2 mL oil-based injection, Drostanolonum 100 mg Syntex	drostanolone propionate	methandriole dipropionate
<i>Masteron</i> —2 mL oil-based injection, Drostanolonum 100 mg Syntex	drostanolone propionate	nandrolone decanoate
Metenolone		
<i>Primobolan Depot</i> —1 mL oil-based injection (100 mg/mL; red label); Schering	metenolone enantate	no steroids but tocopherole
<i>Primobolan Depot</i> —1 mL oil-based injection (100 mg/mL in a brown bottle); Schering	metenolone enantate	progesterone
<i>Primobolan Depot</i> —1 mL oil-based injection (100 mg/mL; bottle with white sealed ring); Schering	metenolone enantate	nandrolone phenylpropionate
<i>Primobolan Depot</i> —1 mL oil-based injection (100 mg/mL; bottle without white sealed ring); Schering	metenolone enantate	nandrolone phenylpropionate
Nandrolone		
<i>Extraboline</i> —2 mL oil-based suspension (100 mg/mL); Genepharma (Greece)	nandrolone decanoate	nandrolone decanoate
<i>Deca Durabolin</i> —2 mL oil-based suspension; Organon Oss. (Netherlands)	nandrolone decanoate	nandrolone decanoate
<i>Deca-Durabolin</i> —2 mL oil-based injection (100 mg/mL); Niadas Athen (Greece)/Organon (Netherlands)	nandrolone decanoate	nandrolone decanoate
<i>Dynabolon</i> —1 mL oil-based injection (80.5 mg); Theramex (Monaco)	nandrolone undecanoate	nandrolone undecanoate
<i>Nandrolone decanoate</i> —1 mL oil-based injection (200 mg/mL); GG Pharmaceutical India	nandrolone decanoate	nandrolone decanoate
<i>Nandrolone decanoate</i> —2 mL oil-based injection (100 mg/mL); Denk München	nandrolone decanoate	nandrolone decanoate
Trenbolone		
<i>Parabolan</i> —10 mL oil-based injection (76 mg/mL); Negma France	trenbolone hexahydrobenzylcarbonate	testosterone propionate + testosterone isocaproate + testosterone decanoate + testosterone phenylpropionate

TABLE 1—Continued.

Product Labeling	Expected Ingredient(s)	Identified Ingredient(s)
<i>Parabolan-Trenbolone</i> —1.5 mL oil-based injection (76 mg); Negma France	trenbolone hexahydrobenzylcarbonate	17-methyltestosterone
<i>Parabolan-Trenbolone</i> —1.5 mL oil-based injection (76 mg); Negma France	trenbolone hexahydrobenzylcarbonate	no steroids
<i>Parabolan-Trenbolone</i> —1.5 mL oil-based injection (76 mg); Negma France	trenbolone hexahydrobenzylcarbonate	nandrolone decanoate
Testosterone		
<i>Ambosex</i> —1 mL oil-based injection; Richter (Germany)		testosterone propionate + testosterone isocaproate
<i>CYTAHOH 250</i> —ca. 1 mL oil-based injection	testosterone propionate + testosterone isocaproate + testosterone phenylpropionate + testosterone decanoate	nandrolone decanoate
<i>Heptylate de Testosterone</i> —1 mL oil-based injection (250 mg/mL); Theramex (Monaco)	testosterone base	nandrolone decanoate
<i>Omnadren</i> —ca. 1 mL oil-based injection; Polfa, Poland	testosterone propionate + testosterone phenylpropionate	testosterone propionate + testosterone phenylpropionate
<i>Sustanon-100</i> —1 mL oil-based injection Organon	testosterone propionate + testosterone isocaproate + testosterone phenylpropionate	testosterone propionate + testosterone isocaproate + testosterone phenylpropionate
<i>Sustanon 250</i> —1 mL oil-based injection; Organon (Turkey)	testosterone propionate + testosterone isocaproate + testosterone decanoate + testosterone phenylpropionate	testosterone propionate + testosterone isocaproate + testosterone decanoate + testosterone phenylpropionate
<i>Sustanon 250</i> —1 mL oil-based injection; Infar (India)	testosterone propionate + testosterone isocaproate + testosterone decanoate + testosterone phenylpropionate	testosterone propionate + testosterone isocaproate + testosterone decanoate + testosterone phenylpropionate
<i>ТЕСТОСТЕРОНА ПРОПΙΟΝΑΤ</i> —ca. 1 mL oil-based injection	testosterone propionate	testosterone propionate
<i>Testosterone Enantate</i> —1 mL oil-based injection (250 mg/mL); Denk München	testosterone enantate	testosterone enantate
<i>Testoviron Depot</i> —1 mL oil-based injection (250 mg); German Remedies Limited (India)	testosterone enantate	testosterone enantate
<i>Testoviron Depot-250</i> —1 mL oil-based injection; Schering	testosterone enantate (+ testosterone propionate)	nandrolone decanoate
Stanozolol		
<i>Stanozolol</i> —10 mL milky suspension (50 mg/mL) International Pharmaceuticals	stanozolol	stanozolol
<i>Stanozolol</i> —1 mL milky suspension (50 mg/mL); Paynes Lab.	stanozolol	stanozolol
<i>Winstrol Depot</i> —1 mL milky suspension; Zambon, S.A.	stanozolol	stanozolol
Tablets		
Metandienone		
<i>METAHΔPOCTEHOΛOΗ</i> —white tablet (200 mg)		metandienone
<i>Methandon</i> —white tablets; Acdhon Bangkok (Thailand)	metandienone	metandienone
Unlabeled pink tablet—(120 mg)		metandienone
Unlabeled white tablet—(210 mg)		metandienone
Oxandrolone		
<i>Oxandrolone</i> —white tablet (150 mg)	oxandrolone	oxandrolone
Oxymetholone		
<i>Anapolon 50</i> —white tablets; Syntex (England)	oxymetholone	metandienone oxymetholone + artefact with methanol
<i>Oxymetholone</i> —white tablet (140 mg)	oxymetholone	metandienone oxymetholone + artefact with methanol
<i>Synasteron 50</i> —white tablets; Syntex (Belgia)	oxymetholone	metandienone oxymetholone + artefact with methanol
Unlabeled white tablets—(130 mg)		
Testosterone		
<i>Oral-Turinabol</i> —blue tablet (70 mg)	4-chlordehydromethyltestosterone	4-chlordehydromethyltestosterone + M-18-pyrolisis product

*Methandriole dipropionate was identified only by comparison with a mass spectra library.

cases metandienone was found, instead of the strong and effective steroid oxymetholone.

Conclusions

Athletes and others find a large variety of anabolic steroid products on the black market. Because the demand is much higher than the supply, the black market is still growing and many of the dealt products often do not contain the purported ingredients. A lot of counterfeits contain completely different substances, are strongly underdosed, or do not contain anabolic substances. Another problem is the doubtful purity and sterility of these products. The manufacturers are trying their best to design appealing, credible, sale-promoting packaging. For example, the label and imprint on the packages are improved constantly; expiration dates and batch numbers are imprinted at a later date; package inserts are enclosed; indented and colored tablets are produced and burnt-in imprints appear on ampules. Even steroid dealers often cannot distinguish between original and counterfeit products. A cautionary remark is necessary about underground guidelines for the use of anabolic steroids (10–12). They contain information about the different characteristics and effects, training programs and dosages, price lists and warnings or descriptions of known fakes.

Acknowledgment

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