Forensic Analysis of Cathinones

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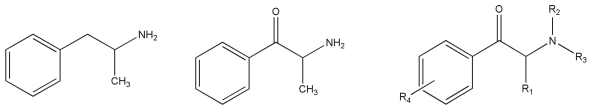
ABSTRACT: In the past decade there has been a significant increase in the popularity of synthetic cathinones in the illegal drug market. They have been easily available from Internet-based vendors as well as at "head shops" and "smart shops". The recent prominence of synthetic cathinones can be attributed to their stimulatory properties similar to those of amphetamines. This paper provides a review on the current popular cathinone derivatives, their history and prevalence in the illegal drug market, legislation of these drugs in various countries, pharmacology, toxicology, and metabolism studies, analysis of toxicology samples (blood, urine, and hair) and criminalistic samples (seized, purchased via the Internet, and synthesized). From the reviewed literature, it is concluded that the products sold as "legal highs" do not only contain cathinone but also cathinone derivatives, and adulterants such as caffeine, lidocaine, and inorganic materials. Full toxicity data is currently unavailable for this drug class and hence more research is required with regard to their analysis and metabolism. Moreover, clandestine chemists are constantly synthesizing new derivatives and hence forensic chemists often need to synthesize and characterize these drugs to confirm the identity of the seized samples. This is expensive as well as time-consuming. Therefore, there is a need for national and international collaboration among forensic chemists to overcome this difficulty.

KEY WORDS: Legal highs, MDPV, mephedrone, methcathinone, synthetic cathinones.

INTRODUCTION

Synthetic cathinones, a class of designer drugs, are structurally and pharmacologically similar to amphetamines. Cathinone (S-2-amino-1-phenyl-1-propanone) is one of the drugs in this class that has a ketone group at the β-carbon atom to the amine in amphetamine structure (**Structure 1**). For this reason these drugs are considered as β-keto analogues of amphetamine.

Cathinone is naturally present in fresh leaves of the Catha edulis plant (**Figure 1**) [47]. It is cultivated in East Africa and the Arabian Peninsula. Different names have been used around the world such as "tchat" in Ethiopia, "qut" in Yemen, "qaad" or "jaad" in Somalia, "miraa" in Kenya, "mairungi" in Uganda, and "muhulo" in Tanzania [37].



Amphetamine Cathinone Generic structure of cathinone

Structure 1. Chemical structures of amphetamine, cathinone, and generic structure of cathinone indicating positions for structural variation.

Figure 1. *Catha edulis* plant [30].

Chewing of fresh *Catha edulis* leaves is popular in certain countries such as Yemen and Somalia [78]; the practice results in a stimulant effect similar to that experienced when amphetamine is taken [31,37,80]. Figure 1 shows the *Catha edulis* plant.

All known cathinone derivatives are either *N*-alkylated (R_2 and R_3), ring-substituted (R_4), or formed by the variation of the α-carbon substituent (R_1) (**Table 1**). There are approximately 30 known cathinone derivatives [47]. These drugs have common, IUPAC, and street names as listed in **Table 2**. For the purpose of this review, common names will be used.

Synthetic cathinones are mostly encountered as white or brown powders in both amorphous and crystalline forms. Tablet forms are less common but sometimes available in the illicit drug market (**Figure 2**). These drugs are ingested and/or insufflated, and can also be injected due to their water-soluble nature [47,76,103]. Other routes of administration include inhalation and rectal or gingival insertion. Parallel routes of administration have also been reported [111]. Mephedrone, as an example, can be

Table 1. Structural differences in selected synthetic cathinones (The substitution relates to Structure 1 [33])

	Functional group[a]			
Name	**R1**	**R2**	**R3**	**R4**
Mephedrone	Me	Me	H	4-Me
Dimethylcathinone	Me	Me	Me	H
Methedrone	Me	H	Me	4-MeO
Methylone	Me	Me	H	3,4-Methylenedioxy
Butylone	Et	Me	H	3,4-Methylenedioxy

[a] Me = methyl; Et = ethyl.