

Project Information:

Title: Evaluation of the IDenta CUSPER™ General Screening Drug and Explosive Test Kits

Evaluation Type: Colorimetric Test Kit Evaluation

Stakeholder: IDenta, Ltd.

Testing Start Date: 06/15/2021 **Testing End Date:** 07/30/2021

Catalog Number: **Lot Numbers:**

Stakeholder Information:

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Executive Summary:

The Forensic Chemistry section of the National Forensic Science Technology Center at Florida International University (NFSTC@FIU) conducted an evaluation on the CUSPER™ General Screening Explosive and General Screening Drug test kits developed by IDenta, LTD. These innovatively designed test kits utilize a Smart-Tip™ Probe, which has an adhesive tip to facilitate the collection of chemical micro-particles from surfaces. Once collection is complete, the Smart-Tip™ is reinserted back into the ridge kit containing a series of reagents. The user breaks the reagent ampoules in order and observes

any significant color changes during each stage of the detection process. The CUSPER™ is designed to be used to test for trace or bulk amounts of drug and explosive substances from different types of surfaces. These Test Kits provided the framework for this evaluation and each kit was assessed for specificity, sensitivity, and selectivity.

Overall, the IDenta CUSPER™ General Drug and Explosive Screening test kits performed extremely well during this evaluation and in some cases was able to detect the drugs and explosives tested during this evaluation down to as low as 5 ug amounts. They proved to be rapid, accurate and reliable for the detection and presumptive identification of controlled substances and explosives.

IDenta CUSPER™ General Screening Drug and Explosive Test Kit Description

The IDenta CUSPER™ is a colorimetric test kit that weighs approximately 25 grams, and measures approximately 9 cm x 4.5 cm x 2 cm. (See Figure 1). The kits come in a box of ten test kits and one procedure card. Each test kit contains reagent capsules which are broken in a sequential numeric order to ultimately achieve a predetermined color change for a positive result. This specific color development would be dependent upon the substance collected on the Smart-Tip™ probe and the kit being utilized for screening.

Figure 1 – IDenta CUSPER™



Materials:

IDenta CUSPER™ General Screening Drugs (#IDT9000T)

IDenta CUSPER™ General Screening Explosive (#IDT0010T)

10 mL volumetric flasks

30 mL clear glass Scintillation Vials

Weigh paper

Disposable plastic spatulas

Bytac® Teflon Aluminum Backing (Catalog# 66110-950, VWR)

List of Samples:

1. Sensitivity

- a. Controlled Substances
 - i. Cocaine Hydrochloride (HCl)
 - ii. Heroin Hydrochloride (HCl)
 - iii. Methamphetamine Hydrochloride (HCl)
- b. Explosives
 - i. 2,4,6-Trinitrotoluene (TNT)
 - ii. 1,3,5-trinitro-1,3,5-triazine (RDX)
 - iii. Urea Nitrate

2. Conformity /Specificity

- a. Controlled Substances:
 - i. Cocaine Hydrochloride (HCl)
 - ii. Cocaine Base
 - iii. Heroin Hydrochloride (HCl)
 - iv. Methamphetamine Hydrochloride (HCl)
 - v. 3,4-Methylenedioxymethamphetamine Hydrochloride (MDMA HCl)
- b. Explosives or precursor chemicals:
 - i. 2,4,6-Trinitrotoluene (TNT)
 - ii. Pentaerythritol tetranitrate (PETN)
 - iii. 1,3,5-trinitro-1,3,5-triazine (RDX)
 - iv. Ammonium Nitrate

3. Selectivity

- a. General Screening-Drugs
 - i. Acetylsalicylic Acid (Aspirin)
 - ii. Lidocaine
 - iii. Guaiacol Glyceryl Ether (Guaifenesin)
 - iv. Diphenhydramine
 - v. Benzphetamine
- b. General Screening-Explosive:

- i. Glycerin
- ii. Nitric Acid
- iii. Potassium Carbonate

Sample Identification Tables:

All chemicals used during this evaluation were purchased from reputable manufacturers at purities of 99% or higher when applicable.

Table 1: Summary of samples tested

	Chemical Analyte(s)	Test Kit	Amount (mg)	Solvent (10mL volumetric flask)
1	Cocaine HCl	Drug	20.00	Methanol
2	Heroin HCl	Drug	20.01	Methanol
3	Cocaine Base	Drug	20.12	Methanol
4	Methamphetamine HCl	Drug	20.27	Methanol
5	MDMA HCl	Drug	20.06	Methanol
6	Aspirin	Drug	20.02	Methanol
7	Dimethyl Sulfone	Drug	20.01	Methanol
8	Lidocaine	Drug	20.06	Methanol
9	Diphenhydramine	Drug	20.10	Methanol
10	Benzphetamine	Drug	20.06	Methanol
11	Guaifenesin	Drug	20.11	Methanol
12	TNT	Explosive	20.04	Acetonitrile
13	PETN	Explosive	20.12	Acetonitrile
14	RDX	Explosive	20.21	Acetonitrile
15	Urea Nitrate	Explosive	20.13	Acetonitrile
16	Ammonium Nitrate	Explosive	20.07	Acetonitrile
17	Glycerin	Explosive	3 mL	Neat
18	Nitric Acid	Explosive	3 mL	Neat
19	Potassium Carbonate	Explosive	20.23	Acetonitrile

Table 2: List of Drugs Tested and Source

Drug of Abuse	CAS #	Standard Source	Part number/Lot number
Methamphetamine HCl	51-57-0	Sigma Aldrich	M8570/ 098K0693
Cocaine HCl	53-21-4	Sigma Aldrich	C5776-5G/059K1139
Heroin HCl	1502-95-0	Lipomed	M-29-HC-5000/29.3B37.1
Cocaine Base	50-36-2	DEA-Adjudicated Case	TS-003/ N/A
MDMA HCl	64057-70-1	Cayman Chemical	13971/ 0460656-17

Table 3: List of Explosives and Precursors Tested

Explosive/precursor	CAS #	Standard Source	Part number/Lot number
2,4,6-Trinitrotoluene (TNT)	118-96-7	Omni Explosives	SHE-TNT-20G-24/10JUN11/FXG
RDX	121-82-4	Omni Explosives	K9-DC-RDX/06AUG10SE1/DET/BLK/FXG
Ammonium nitrate	6484-52-2	Sigma Aldrich	221244-500/SHBD9710V
Urea nitrate	124-27-0	Fisher Scientific/TCI America™	U00150/18078
Pentaerythritol Tetranitrate (PETN)	78-11-5	Omni Explosives	DC100-100FT/05MAY11G1/Dyno/White/FXG

Table 4: List of Controlled Substance Dilutants/Cutting Agents

Toxic Industrial Chemical	CAS #	Standard Source	Part number/Lot number
Dimethyl Sulfone	67-71-0	Gaylord Chemical	GCC3/ 09-028-02
Lidocaine	137-58-6	Sigma Aldrich	C298-500/101K0120
Diphenhydramine	147-24-0	Sigma Aldrich	D3630-5G/096K0036
Benzphetamine	5411-22-3	Sigma Aldrich	B8263/105F0122
Guaifenesin	93-14-1	Sigma Aldrich	G-5627/109K1554V
Aspirin	50-78-2	Sigma Aldrich	A2093/MKBT1587V

Table 5: List of Explosive Precursors

Compound	CAS#	Source	Brand/Part Number
Glycerin	56-81-5	Fisher Scientific	G33-500/031317
Potassium Carbonate	584-08-7	Fisher Scientific	P208-500/ 206894
Nitric Acid, 65-70%	7697-37-2	Sigma Aldrich	84381/424036

Table 6: List of Solvents

Compound	CAS#	Source	Brand/Part Number
Methanol	67-561-1	Fisher Scientific	A412-1/116813
Acetonitrile	75-05-8	Fisher Scientific	A21-4/ 007511

Table 7: Substrate

Substrate	Brand/Part Number
Bytac®, Aluminum backed	Catalog # 66110-950, VWR

General Procedure

The step-by-step process of sample preparation is outlined below and operation of the CUSPER™ test kits followed all manufacturer's recommended procedures and guidelines. Each sample was prepared and interrogated in triplicate.

Sample Preparation and Analysis

1. For each substance in the Chemicals and Solvents listed above, 20 milligrams of sample was weighed out onto a new 3" x 3" piece of weigh paper using an analytical balance.
2. The previously weighed samples were transferred into individual, clean, properly labeled 10 mL volumetric flasks and filled to the graduation or fill line using an appropriate solvent. (See Table 1)
3. Each solution was vortexed to ensure solution homogeneity and thorough solubility of the solute within the solvent.
4. The 2 mg/mL solutions were left to stand until the solute was observed to be completely dissolved in solution.
5. A manual pipette and clean disposable tip were used to remove and dispense a specific volume of sample from the known concentration of analyte solution to achieve the desired amount of analyte on the clean Bytac™ strip. The labeled Bytac™ strip was to dry, unless it was a liquid sample (i.e., nitric acid).
6. The dried Bytac™ sample strip containing the dried sample was swiped with the CUSPER™ Smart-Tip™ probe.
7. The Smart-Tip™ probe was inserted into the body of the test unit and checked to ensure that it was locked into position.
8. Analysis was conducted using the manufacturer's instructions and the results were documented.
9. Steps 6 through 8 were repeated in triplicate for each sample.

Sensitivity

The sensitivity of the CUSPER™ were performed at six different concentrations to establish a range of sensitivity. Volume delivered from 2 mg/mL solution onto Bytac™ strip.

Table 8: Analyte Concentrations

Pipette amount (µL)	Amount (mg) deposited	Amount (µg) deposited
2.5	0.005	5
5	0.010	10
25	0.050	50
50	0.100	100
100	0.200	200
150	0.300	300

The following analytes were chosen to represent the different drug and explosive categories that these test kits can detect:

- **Illicit Drugs**
 - Cocaine HCl
 - Heroin (Opiates)
 - Methamphetamine (Amphetamines)
- **Explosives**
 - TNT (Nitroaromatic)
 - RDX (Nitramine)
 - UN (Inorganic nitrate)

Conformity/Specificity

The following reference standards were presented to the appropriate CUSPER™ General Screening kit to examine the accuracy of the identifications in concentrations of 200 µg each.

- **Illicit Drugs and Cutting Agents**
 - Cocaine HCl
 - Cocaine Base
 - Heroin
 - Methamphetamine
 - 3,4-Methylenedioxymethamphetamine (MDMA)
- **Explosives and Precursors**
 - TNT
 - PETN
 - RDX
 - Ammonium Nitrate

Selectivity

False positives or misidentifications are a significant concern for explosive and drug analysis in the field as well as in the Forensic Laboratory. Substances commonly used as diluents and/or counterfeits were analyzed on the CUSPER™ General Drugs Screening test kits and structurally similar compounds were analyzed on the CUSPER™ explosive detection kit. 200 µg samples were analyzed on each type of test kit to determine if any yielded incorrect results.

Each of the compounds listed below were interrogated using the appropriate CUSPER™ General Screening Drug test kit:

- Aspirin

- Lidocaine
- Dimethyl sulfone
- Guaifenesin
- Diphenhydramine
- Benzphetamine

Each of the compounds listed below were interrogated using the appropriate CUSPER™ General Screening Explosive test kit:

- Glycerin
- Nitric acid
- Potassium carbonate

Results and Discussion:

A result was deemed positive for a suspected drug or explosive if the correct color change occurred, as indicated on the procedure card insert. It was noted that in most cases, the color change was evident and immediate; however, in some instances the color change was slower to develop, and all color changes were notated within one minute.

Sensitivity

A total of 164 trials were performed on 6 samples to evaluate the sensitivity of the two General Screening test kits for common drug and explosive analytes. The General Screening Drug Test Kit was able to detect heroin hydrochloride and methamphetamine down to 5 ug. However, further testing would be required to determine the lower limit of detection for these two drugs. It was observed that the General Drug Screening kits were able to detect cocaine hydrochloride 2 out of 3 replicates at the 5 ug amount; because of this observation, the cut-off for the detection of cocaine hydrochloride is ~ at the 5 ug amount.

The General Screening Explosive test kit was able to detect TNT down to a 5 ug for all 3 replicates tested. RDX was able to be successfully detected at 10 ug for 3 out of the 3 replicates but only 2 out of the 3 for at the 5 ug amount. It was noted that the General Screening Explosive test kits did have some difficulty with urea nitrate at concentrations below 100 ug and at the 300 ug amount.

Table 9: Sensitivity General Screening-Drugs Test Kit Results

Sample	Sample Amount (µg)	Replicate 1	Replicate 2	Replicate 3
Cocaine HCl	5	Blue (Pos)	No Color Change (Neg)	Blue (Pos)
	10	Blue (Pos)	Blue (Pos)	Blue (Pos)
	50	Blue (Pos)	Blue (Pos)	Blue (Pos)
	100	Blue (Pos)	Blue (Pos)	Blue (Pos)
	200	Blue (Pos)	Blue (Pos)	Blue (Pos)
	300	Blue (Pos)	Blue (Pos)	Blue (Pos)
Heroin HCl	5	Violet (Pos)	Violet (Pos)	Violet (Pos)
	10	Violet (Pos)	Violet (Pos)	Violet (Pos)
	50	Violet (Pos)	Violet (Pos)	Violet (Pos)
	100	Violet (Pos)	Violet (Pos)	Violet (Pos)
	200	Violet (Pos)	Violet (Pos)	Violet (Pos)
	300	Violet (Pos)	Violet (Pos)	Violet (Pos)
Methamphetamine HCl	5	Violet (Pos)	Violet (Pos)	Violet (Pos)
	10	Violet (Pos)	Violet (Pos)	Violet (Pos)
	50	Violet (Pos)	Violet (Pos)	Violet (Pos)
	100	Violet (Pos)	Violet (Pos)	Violet (Pos)
	200	Violet (Pos)	Violet (Pos)	Violet (Pos)
	300	Violet (Pos)	Violet (Pos)	Violet (Pos)

Table 10: Sensitivity General Screening-Explosive Test Kit Results

Sample	Sample Amount (µg)	Replicate 1	Replicate 2	Replicate 3
TNT	5	Violet (Pos)	Violet (Pos)	Violet (Pos)
	10	Violet (Pos)	Violet (Pos)	Violet (Pos)
	50	Violet (Pos)	Violet (Pos)	Violet (Pos)
	100	Violet (Pos)	Violet (Pos)	Violet (Pos)
	200	Violet	Violet	Violet
	300	Violet (Pos)	Violet (Pos)	Violet (Pos)
RDX	5	Orange/Pink (Pos)	No Color Change (Neg)	Orange/Pink (Neg)
	10	Orange/Pink (Pos)	Orange/Pink (Pos)	Orange/Pink (Pos)
	50	Orange/Pink (Pos)	Orange/Pink (Pos)	Orange/Pink (Pos)
	100	Orange/Pink (Pos)	Orange/Pink (Pos)	Orange/Pink (Pos)
	200	Orange/Pink (Pos)	Orange/Pink (Pos)	Orange/Pink (Pos)
	300	Orange/Pink (Pos)	Orange/Pink (Pos)	Orange/Pink (Pos)
Urea Nitrate	5	No Color Change (Neg)	No Color Change (Neg)	No Color Change (Neg)
	10	No Color Change (Neg)	No Color Change (Neg)	No Color Change (Neg)
	50	Orange/Pink (Pos)	No Color Change (Neg)	No Color Change (Neg)
	100	Orange/Pink (Pos)	Orange/Pink (Pos)	Orange/Pink (Pos)
	200	Orange/Pink (Pos)	Orange/Pink (Pos)	Orange/Pink (Pos)
	300	No Color Change (Neg)	No Color Change (Neg)	Orange/Pink (Pos)

Conformity/Specificity

A total of 27 trials were performed on 5 illicit drugs and 4 explosive chemical samples. The CUSPER™ test kit provided the correct color change or positive result in all 27 trials for a 100% correct identification for each analyte tested.

Table 11: Conformity/Specificity General Screening-Drugs Test Kit Results

Sample	Sample Amount (µg)	Replicate 1	Replicate 2	Replicate 3
Cocaine HCl	200	Blue (Pos)	Blue (Pos)	Blue (Pos)
Cocaine Base	200	Blue (Pos)	Blue (Pos)	Blue (Pos)
Heroin HCl	200	Violet (Pos)	Violet (Pos)	Violet (Pos)
Methamphetamine HCl	200	Violet (Pos)	Violet (Pos)	Violet (Pos)
MDMA HCl	200	Violet (Pos)	Violet (Pos)	Violet (Pos)

Table 12: Conformity/Specificity General Screening-Explosive Test Kit Results

Sample	Sample Amount (µg)	Replicate 1	Replicate 2	Replicate 3
TNT	200	Violet (Pos)	Violet (Pos)	Violet (Pos)
PETN	200	Orange/Pink (Pos)	Orange/Pink (Pos)	Orange/Pink (Pos)
RDX	200	Orange/Pink (Pos)	Orange/Pink (Pos)	Orange/Pink (Pos)
Ammonium Nitrate	200	Pink (Pos)	Pink (Pos)	Pink (Pos)

Selectivity

A total of 27 trials were performed on 9 samples. The CUSPER™ General Screening Drugs resulted in no color change for 3 out of 3 trials for each of the following: aspirin, lidocaine, dimethyl sulfone, and guaifenesin which resulted in no false positives (FP) results. However, a violet color change or FP result was noted to occur for all the trials for both the diphenhydramine and benzphetamine.

Diphenhydramine and benzphetamine are known to produce false positives for many of the available drug test kits on the market. The CUSPER™ General Screening Explosive test kits provided no color change for all 3 trials for both the glycerin and potassium carbonate samples, but an immediate purple color change was noted for all 3 trials for nitric acid. Nitric acid is a common precursor for many monomolecular HME explosives and has structural similarities that are known to produce false positives in colorimetric explosive testing kits (ETKs).

Table 13: Selectivity General Screening-Drugs Test Kit Results

Sample	Sample Amount (µg)	Replicate 1	Replicate 2	Replicate 3
Aspirin	200	No Color Change (Neg)	No Color Change (Neg)	No Color Change (Neg)
Lidocaine	200	No Color Change (Neg)	No Color Change (Neg)	No Color Change (Neg)
Dimethyl Sulfone	200	No Color Change (Neg)	No Color Change (Neg)	No Color Change (Neg)
Guaifenesin	200	No Color Change (Neg)	No Color Change (Neg)	No Color Change (Neg)
Diphenhydramine	200	Violet (FP)	Violet (FP)	Violet (FP)
Benzphetamine	200	Violet (FP)	Violet (FP)	Violet (FP)

Table 14: Selectivity General Screening-Explosives Test Kit Results

Sample	Sample Amount (µg)	Replicate 1	Replicate 2	Replicate 3
Nitric Acid	200	Violet (FP)	Violet (FP)	Violet (FP)
Glycerin	200	No Color Change (Neg)	No Color Change (Neg)	No Color Change (Neg)
Potassium Carbonate	200	No Color Change (Neg)	No Color Change (Neg)	No Color Change (Neg)

Findings

Strengths

- The General Screening Drug and Explosive test kits are extremely sensitive and capable of detecting trace amounts of target analytes down to as low as 5 ug amounts for some of the drug and explosives tested.
- The ability to screen for multiple types of drugs or explosives with one test kit saves the end user time and the agency money.
- The test kits are easy to use, and operator training can be accomplished quickly.
- The General Screening IDenta CUSPER™ test kits performed with accuracy and reproducibility for most of the samples tested.
- Each box of test kits contains a highly detailed instruction sheet.
- The IDenta CUSPER™ can be used with powders, liquids, and solids.
- The test kits have a three-year shelf life, with all tests evaluated expiring 06/2024. Most of the other manufacturer explosive test kits on the market today have between an 18 to 24-month shelf life.
- Lot numbers and expiration dates are clearly labeled on the outside of each test kit.
- The General Screening kits can be carried individually and well designed for optimal analyte sensitivity ruggedness.

Suggestions for Improvement

- The label and box colors for the General Screening Drug and Explosive test kits are too similar and vary only by shades. It is suggested that both the label and box colors for each of these kits be more varied in color to avoid potential safety issues due to chemical reactions or accidental test kit misuse.
- Reagent capsules are extremely rigid and often difficult to break. This is especially true on the General Screening Explosives test kit on capsule two.

Conclusion:

The IDenta CUSPER™ General Screening Drugs and Explosive test kits are an innovative colorimetric test capable of presumptively detecting various drug and explosive materials in trace amounts down to 5 ug for most of the analytes tested in this evaluation. Overall, the IDenta CUSPER™ General Screening test kits are an effective detection device for screening liquids, powders and surfaces for explosives and illicit drugs.