

# LZI Cannabinoids (cTHC) 25 Enzyme Immunoassay

IVD For In Vitro Diagnostic Use Only



REF 0070c (100/37.5 mL R<sub>1</sub>/R<sub>2</sub> Kit)  
0071c (1000/375 mL R<sub>1</sub>/R<sub>2</sub> Kit)



## Lin-Zhi International, Inc.

### Intended Use

The Lin-Zhi International, Inc. (LZI) Cannabinoids (cTHC) Enzyme Immunoassay is intended for the qualitative and semi-quantitative determination of cannabinoids in human urine using 11-nor- $\Delta^9$ -THC-9-COOH, (the major metabolite of THC, referred to hereafter as cTHC). The calibrator at the cutoff has a value of 25 ng/mL. The semi-quantitative mode is for purposes of (1) enabling laboratories to determine an appropriate dilution of the specimen for confirmation by a confirmatory method such as GCMS or (2) permitting laboratories to establish quality control procedures. The assay is designed for prescription use with a number of automated clinical chemistry analyzers. These assays are for prescription use only.

**The assay provides only a preliminary analytical result. A more specific alternative analytical chemistry method must be used in order to obtain a confirmed analytical result. Gas or Liquid Chromatography/Mass Spectrometry (GC/MS or LC/MS) are the preferred confirmatory methods (1, 2). Clinical consideration and professional judgment should be exercised with any drug of abuse test result, particularly when the preliminary test result is positive.**

### Summary and Explanation of Test

The principal, active constituent in marijuana or hashish, obtained from the *Cannabis sativa* plant, is  $\Delta^1$ -3, 4-*trans* tetrahydrocannabinol, frequently referred to as  $\Delta^9$ -tetrahydrocannabinol or  $\Delta^9$ -THC. Cannabis has been used for its euphoric effects for over 4000 years (3). It is one of the most commonly used drugs in the United States.

Marijuana is frequently self-administered for its mood-altering properties. Chronic use has been shown to cause reversible psychological impairment, abstinence syndrome, and development of tolerance (4). At a low dose, it produces mixed depressant and stimulant effects; at higher dose, marijuana acts as a CNS depressant (5-7).

In the past few decades, research has confirmed the presence of an endogenous endocannabinoid system or ECS (8). Endocannabinoids are produced within the human body and activate two known cannabinoid receptors, CB<sub>1</sub> and CB<sub>2</sub> (9). The CB<sub>1</sub> receptor is localized primarily to the brain and is thought to be responsible for the euphoric and anticonvulsive effects of cannabis, whereas the CB<sub>2</sub> receptor is found primarily in the immune system and thought to be responsible for the anti-inflammatory effects of  $\Delta^9$ -THC (10-12).

Studies published in 2006 revealed that  $\Delta^9$ -THC may actually induce cell death (13) and may even be a viable anti-tumor target (14). Due to the role the ECS may play in a number of physiological processes, much interest in the use of synthetic ECS ligands for therapeutic purposes remains high (15-17).  $\Delta^9$ -THC is easily absorbed by inhalation (smoking) or ingestion. Due to its highly fat-soluble nature,  $\Delta^9$ -THC is readily deposited in fatty tissues, where it may remain for days or even weeks (5). It is primarily metabolized in the liver to a variety of compounds, the major one being the 11-nor- $\Delta^9$ -tetrahydrocannabinol-9-carboxylic acid (11-nor- $\Delta^9$ -THC-9-COOH) (6, 7). Approximately 70 % of THC is excreted in feces and urine within 72 hours of administration (18).

### Assay Principle

The LZI Cannabinoids assay is a homogeneous enzyme immunoassay with ready-to-use liquid reagent. The assay is based on competition between drug in the sample and drug labeled with the enzyme glucose-6-phosphate dehydrogenase (G6PDH) for a fixed amount of antibody in the reagent (19). Enzyme activity decreases upon binding to the antibody, and the drug concentration in the sample is measured in terms of enzyme activity. In the absence of drug in the sample, cannabinoid derivative-labeled G6PDH conjugate is bound to antibody, and the enzyme activity is inhibited. On the other hand, when drug is present in the sample, antibody binds to free drug; the unbound cannabinoid derivative-labeled G6PDH then exhibits its maximal enzyme activity. Active enzyme converts nicotinamide adenine dinucleotide (NAD) to NADH, resulting in an absorbance change that can be measured spectrophotometrically at a 340 nm primary wavelength.

### Reagents Provided

**Antibody/Substrate Reagent (R<sub>1</sub>):** Contains mouse monoclonal anti-cannabinoid antibody, glucose-6-phosphate (G6P), nicotinamide adenine dinucleotide (NAD), and sodium azide (0.09 %) as a preservative.

**Enzyme-drug Conjugate Reagent (R<sub>2</sub>):** Contains glucose-6-phosphate dehydrogenase (G6PDH) labeled with cannabinoid in buffer with sodium azide (0.09 %) as a preservative.

### Calibrators and Controls\*

\*Calibrators and Controls are 5 mL, sold separately, and contain negative human urine with sodium azide as a preservative.

THC 25 Calibrators	REF
THC Negative Calibrator	0002c
THC Low Calibrator: Contains 12.5 ng/mL cTHC metabolite	0072c
THC Cutoff Calibrator: Contains 25 ng/mL cTHC metabolite	0073c
THC Intermediate Calibrator: Contains 37.5 ng/mL cTHC metabolite	0007c
THC High Calibrator: Contains 50 ng/mL cTHC metabolite	0075c
THC 25 Controls	REF
THC Level 1 Control: Contains 18.75 ng/mL cTHC metabolite	0006c
THC Level 2 Control: Contains 31.25 ng/mL cTHC metabolite	0074c

### Precautions and Warning

- This test is for in vitro diagnostic use only. Harmful if swallowed.
- Reagent contains sodium azide as a preservative, which may form explosive compounds in metal drain lines. When disposing such reagents or wastes always flush with a large volume of water to prevent azide build-up. See National Institute for Occupational Safety and Health Bulletin: Explosive Azide Hazards (20).
- Do not use the reagents beyond their expiration dates.
- For USA: Caution: Federal law restricts this device to sale by or on the order of a physician.

### Reagent Preparation and Storage

The reagents are ready-to-use. No reagent preparation is required. All assay components should be refrigerated at 2-8°C when not in use.

### Specimen Collection and Handling

Urine samples may be collected in plastic or glass containers. Some plastics may absorb drugs (21-23). Use of plastics such as polyethylene is recommended (24). Use fresh urine specimens for the test. If a sample cannot be analyzed immediately, it may be refrigerated at 2-8°C for up to seven days (25, 26). For longer storage, keep sample frozen at -20°C and then thaw before use. Studies have shown  $\Delta^9$ -THC analytes in urine are stable at -20°C for up to 70 days (26-28). Samples should be at room temperature (18-25°C) for testing. Samples with high turbidity should be centrifuged before analysis. Adulteration may cause erroneous results. If sample adulteration is suspected, obtain a new sample and forward both samples to the laboratory for testing. Handle all urine specimens as if they are potentially infectious.

### Instrument

Clinical chemistry analyzers capable of maintaining a constant temperature, pipetting sample, mixing reagents, measuring enzyme rates at a 340 nm primary wavelength and timing the reaction accurately can be used to perform this homogeneous immunoassay.

Performance characteristics presented in this package insert have been validated on the Hitachi 717. If other instruments are used, performance will need to be validated by the laboratory (29, 30).

### Assay Procedure

Analyzers with the specifications indicated above are suitable for performing this homogeneous enzyme immunoassay. Refer to the specific parameters used for each analyzer before performing the assay. Typical assay parameters used for the Hitachi 717 analyzer include a 20  $\mu$ L sample, 155  $\mu$ L of antibody reagent (R<sub>1</sub>), and 75  $\mu$ L of enzyme conjugate reagent (R<sub>2</sub>) in 37°C incubation temperature, 30-35 reading frames, and a 340 nm primary wavelength. For qualitative analysis use the 25 ng/mL as the cutoff calibrator. For semi-quantitative analysis, use all five calibrators. Recalibration should be performed after reagent bottle change or if there is a change in calibrators or reagent lot. Two levels of controls are also available for monitoring of the cutoff level: use the 18.75 ng/mL and 31.25 ng/mL for the 25 ng/mL cutoff level.

## Calibration and Quality Control

Good laboratory practices recommend the use of both a positive and negative control near the cutoff to ensure proper assay performance. Controls should be run with each new calibration and after specific maintenance or troubleshooting procedures, as detailed in the instrument system manual. Each laboratory should establish its own quality control frequency. If any trends or sudden change in control value are observed, review all operating parameters, or contact LZI technical support for further assistance. Laboratories should comply with all federal, state, and local laws, guidelines and regulations.

## Results

**Note:** A preliminary positive test result does not necessarily mean a person took illegal drugs, and a negative test result does not necessarily mean a person did not take illegal drugs. There are number of factors that influence the reliability of drug tests.

**Qualitative:** The cutoff calibrator, which contains 25 ng/mL of cTHC, is used as a reference for distinguishing a preliminary positive from negative samples. A sample with a change in absorbance ( $\Delta A/\text{min}$ ) equal to, or greater than, that obtained with the cutoff calibrator is considered a preliminary positive. A sample with a change in absorbance ( $\Delta A/\text{min}$ ) lower than that obtained with the cutoff calibrator is considered negative.

**Semi-Quantitative:** The semi-quantitative mode is for purposes of (1) enabling laboratories to determine an appropriate dilution of the specimen for verification by a confirmatory method such as GC/MS, LC/MS or (2) permitting laboratories to establish quality control procedures. When an approximation of concentration is required, a calibration curve can be established with five calibrators. The concentration of cTHC in the sample may then be estimated from the calibration curve.

**Interpretation:** The semi-quantitative mode is for purposes of (1) enabling laboratories to determine an appropriate dilution of the specimen for confirmation by a confirmatory method such as GC/MS or (2) permitting laboratories to establish quality control procedures.

## Limitations

1. A preliminary positive result from the assay indicates only the presence of cannabinoids.
2. The test is not intended for quantifying these single analytes in samples.
3. A preliminary positive result does not necessarily indicate drug abuse.
4. A negative result does not necessarily mean a person did not take illegal drugs.
5. Care should be taken when reporting results, as numerous factors (e.g., fluid intake, endogenous or exogenous interferents) may influence the urine test result.
6. Preliminary positive results should be confirmed by other affirmative, analytical chemistry methods (e.g., chromatography), preferably GC/MS or LC/MS.
7. The test is designed for use with human urine only.
8. The test is not for therapeutic drug monitoring.

## Typical Performance Characteristics

The results shown below were performed with a single Hitachi 717 automated clinical chemistry analyzer.

### Precision:

Qualitative analysis: Typical results ( $\Delta A/\text{min}$ ) are as follows:

Concentration	Within Run (N=22)			Total Precision (N=88)		
	Mean	SD	% CV	Mean	SD	% CV
0.0 ng/mL	441.6	2.5	0.6 %	441.6	3.1	0.7 %
6.25 ng/mL	465.8	2.9	0.6 %	465.8	4.0	0.9 %
12.50 ng/mL	492.5	3.8	0.8 %	492.5	4.0	0.8 %
18.75 ng/mL	522.6	2.8	0.5 %	522.6	3.5	0.7 %
25.00 ng/mL	553.5	2.7	0.5 %	553.5	3.4	0.6 %
31.25 ng/mL	579.8	3.5	0.6 %	579.8	3.9	0.7 %
37.50 ng/mL	607.9	4.7	0.8 %	607.9	4.8	0.8 %
43.75 ng/mL	630.4	2.9	0.5 %	630.4	3.7	0.6 %
50.00 ng/mL	648.1	3.1	0.5 %	648.1	4.0	0.6 %

25 ng/mL Cutoff Result:		Within Run (N=22)		Total Precision (N=88)	
Concentration	% of Cutoff	# Samples	EIA Result	# Samples	EIA Result
0.0 ng/mL	0 %	22	22 Neg	88	88 Neg
6.25 ng/mL	25 %	22	22 Neg	88	88 Neg
12.50 ng/mL	50 %	22	22 Neg	88	88 Neg
18.75 ng/mL	75 %	22	22 Neg	88	88 Neg
25.00 ng/mL	100 %	22	11 Neg/ 11 Pos	88	40 Neg/ 48 Pos
31.25 ng/mL	125 %	22	22 Pos	88	88 Pos
37.50 ng/mL	150 %	22	22 Pos	88	88 Pos
43.75 ng/mL	175 %	22	22 Pos	88	88 Pos
50.00 ng/mL	200 %	22	22 Pos	88	88 Pos

Semi-quantitative analysis: Typical results (ng/mL) are as follows:

Concentration	Within Run (N=22)			Total Precision (N=88)		
	Mean	SD	% CV	Mean	SD	% CV
0.0 ng/mL	0.5	0.6	116.3 %	0.5	0.7	161.0 %
6.25 ng/mL	6.7	0.6	9.2 %	6.7	0.7	10.5 %
12.50 ng/mL	12.5	0.5	4.2 %	12.5	0.7	5.8 %
18.75 ng/mL	18.2	0.6	3.5 %	18.2	0.9	4.9 %
25.00 ng/mL	24.4	0.9	3.5 %	24.4	1.0	4.1 %
31.25 ng/mL	30.5	0.8	2.7 %	30.5	1.1	3.6 %
37.50 ng/mL	37.6	1.0	2.5 %	37.6	1.2	3.0 %
43.75 ng/mL	43.9	1.0	2.3 %	43.9	1.2	2.8 %
50.00 ng/mL	49.4	1.3	2.5 %	49.4	1.5	2.9 %

25 ng/mL Cutoff Result:		Within Run (N=22)		Total Precision (N=88)	
Concentration	% of Cutoff	# Samples	EIA Result	# Samples	EIA Result
0.0 ng/mL	0 %	22	22 Neg	88	88 Neg
6.25 ng/mL	25 %	22	22 Neg	88	88 Neg
12.50 ng/mL	50 %	22	22 Neg	88	88 Neg
18.75 ng/mL	75 %	22	22 Neg	88	88 Neg
25.00 ng/mL	100 %	22	19 Neg/ 8 Pos	88	69 Neg/ 19 Pos
31.25 ng/mL	125 %	22	22 Pos	88	88 Pos
37.50 ng/mL	150 %	22	22 Pos	88	88 Pos
43.75 ng/mL	175 %	22	22 Pos	88	88 Pos
50.00 ng/mL	200 %	22	22 Pos	88	88 Pos

**Sensitivity:** Sensitivity, defined as the lowest concentration that can be differentiated from the negative urine with 95 % confidence, was 5 ng/mL for THC 25 in both qualitative and semi-quantitative analyses.

**Accuracy:** Fifty-five (55) negative and 55 positive specimens for a total of 110 unaltered clinical urine specimens were tested with the LZI Cannabinoids (cTHC) Enzyme Immunoassay at the 25 ng/mL cutoff and confirmed with GC/MS or LC/MS. Specimens with a concentration of cTHC greater than 25 ng/mL, determined by GC/MS or LC/MS, were defined as positive, and specimens with lower concentrations by GC/MS or LC/MS were defined as negative in the tables below. Near cutoff samples are defined as  $\pm 50$  % of the cutoff value. The correlation results are summarized as follows:

THC 25 - Semi-Quantitative Accuracy Study:

25 ng/mL Cutoff	Neg	<50 % below the cutoff	Near Cutoff Neg	Near Cutoff Pos	> 50 % above the cutoff	% Agreement
Positive	0	1*	7**	18	37	100.0 %
Negative	14	24	9	0	0	85.5 %

THC 25 - Qualitative Accuracy Study:

25 ng/mL Cutoff	Neg	<50 % below the cutoff	Near Cutoff Neg	Near Cutoff Pos	> 50 % above the cutoff	% Agreement
Positive*	0	1*	7**	18	37	100.0 %
Negative*	14	24	9	0	0	85.5 %

Summary of Discordant Results in Semi-Quantitative Mode:

Semi-Quantitative Mode	Cutoff Value	LZI cTHC EIA (Neg/Pos)	cTHC GC/MS Value (ng/mL)
		25 ng/mL	Positive
		Positive	19
		Positive	20
		Positive	21
		Positive	23
		Positive	23
		Positive	24
		Positive	24

Summary of Discordant Results in Qualitative Mode

Qualitative Mode	Cutoff Value	LZI cTHC EIA (Neg/Pos)	cTHC GC/MS Value (ng/mL)
		25 ng/mL	Positive
		Positive	19
		Positive	20
		Positive	21
		Positive	23
		Positive	23
		Positive	24
		Positive	24

<sup>o</sup>The discrepant result showing a GC/MS value of 7 ng/mL was initially obtained in the first method comparison study. Due to a small sample size received, no retest was done for this sample. Following additional method comparison studies, we believe the root cause of the error was derived from initial GC/MS readings. The additional method comparison studies and initial studies have been combined in the accuracy report listed above.

**Analytical Recovery:** To demonstrate linearity for purposes of sample dilution and quality control (see semi-quantitative results section), a drug-free urine pool was spiked with cTHC and serially diluted. Each sample was run in 10 replicates and the average was used to determine the functional linearity range of the assay. When comparing the result (y) and target (x) value, using the least squares regression technique, the regression equation and correlation are as follows:

$$y = 0.954x + 6.6625, r^2 = 0.9972$$

% Dilution	Expected Value (ng/mL)	Observed Value (ng/mL)	% Recovery
100	0	0.9	N/A
90	5	5.4	108.8 %
80	10	9.6	95.6 %
70	15	13.4	89.3 %
60	20	18.0	90.1 %
50	25	23.3	93.4 %
40	30	28.0	93.5 %
30	35	33.4	95.3 %
20	40	38.9	97.3 %
10	45	44.3	98.5 %
0	50	47.6	95.1 %

**Specificity:** Various potentially interfering substances were tested for cross-reactivity with the assay. Test compounds were spiked into the drug-free urine calibrator matrix individually to various concentrations and evaluated against the cutoff calibrator.

The table below lists the concentration of each test compound that gave a response approximately equivalent to that of the cutoff calibrator (as positive) or the maximal concentration of the compound tested that gave a response below the response of the cutoff calibrator (as negative).

**Structurally Related Cannabinoids (cTHC) Compounds:**

Compound	Target [ ] (ng/mL)	EIA [ ] (ng/mL)	% Cross-Reactivity
8-β-hydroxy-Δ <sup>9</sup> -THC	40	26.2	65.5 %
8-β-11-dihydroxy-Δ <sup>9</sup> -THC	40	20.2	50.5 %
Cannabidiol	4500	21.6	0.5 %
Cannabinol	120	28.2	23.5 %
exo-THC	50	28.8	57.5 %
<i>l</i> -11-Hydroxy-Δ <sup>9</sup> -THC	40	37.6	94.0 %
<i>l</i> -11-Nor-Δ <sup>9</sup> -THC-9-Carboxylic Acid	25	24.3	97.3 %
<i>l</i> -11-Nor-Δ <sup>9</sup> -THC-9-Carboxylic Acyl-Glucuronide	1500	21.3	1.4 %
Δ <sup>8</sup> -THC	50	31.8	63.6 %
Δ <sup>9</sup> -THC	100	35.8	35.8 %

**Structurally Unrelated Compounds:**

Compound	Target [ ] (ng/mL)	EIA [ ] (ng/mL)	% Cross-Reactivity
Acetaminophen	500,000	0.0	0.000 %
Acetylsalicylic Acid	500,000	0.0	0.000 %
Amitriptyline	500,000	1.8	0.000 %
Amobarbital	500,000	6.0	0.001 %
Amphetamine	500,000	8.3	0.002 %
Benzoyllecgonine	500,000	10.0	0.002 %
Bupropion	500,000	8.9	0.002 %
Caffeine	500,000	3.1	0.001 %
Chlorpheniramine	500,000	0.0	0.000 %
Chlorpromazine	500,000	0.0	0.000 %
Cocaine	500,000	1.9	0.000 %
Codeine	500,000	4.7	0.001 %
Dextromethorphan	500,000	5.3	0.001 %
Ecgonine Methyl Ester	500,000	5.2	0.001 %
d,l-Ephedrine	500,000	5.3	0.001 %
Imipramine	500,000	1.3	0.000 %
JWH-018(1-Pentyl-3(1-Naphthoyl)Indole)	500,000	2.4	0.000 %
JWH-073(1-Butyl-3(1-Naphthoyl)Indole)	500,000	3.1	0.001 %
Lidocaine	500,000	1.9	0.000 %
Meperidine	500,000	1.3	0.000 %
Methadone	500,000	1.9	0.000 %
Methamphetamine	500,000	1.1	0.000 %
Methaqualone	500,000	3.6	0.001 %
Morphine	500,000	0.0	0.000 %
Nortriptyline	500,000	0.0	0.000 %
Oxazepam	500,000	0.0	0.000 %
Phencyclidine	500,000	1.1	0.000 %
Phenobarbital	500,000	2.8	0.001 %
Promethazine	500,000	3.0	0.001 %
Propoxyphene	500,000	3.7	0.001 %

**Structurally Unrelated Compounds, continued:**

Compound	Target [ ] (ng/mL)	EIA [ ] (ng/mL)	% Cross-Reactivity
Ranitidine	500,000	2.8	0.001 %
Secobarbital	500,000	2.4	0.000 %
Valproic Acid	500,000	2.8	0.001 %

*It is possible that other substances and/or factors not listed above may interfere with the test and cause false positive results.*

**Interference: Endogenous Substances**

The following endogenous compounds were spiked into a pool of processed negative urine (Cannabinoids free urine) to the desired concentrations listed in the table below. Standards of cTHC were then spiked into the pools of processed urine containing the endogenous compounds to the concentrations listed below as positive or negative controls. Results indicate there is no major interference with these compounds at physiologically relevant concentrations, as all spiked samples gave correct responding positive/negative results against the cutoff values of 25 ng/mL. Results are summarized in the following table:

Interfering Substances	Spiked [ ] (mg/dL)	0 ng/mL (ng/mL)	18.75 ng/mL Control (ng/mL)	31.25 ng/mL Control (ng/mL)
None		1.6	18.9	30.2
Acetone	1000	2.4	18.5	30.5
Ascorbic Acid	500	0.0	15.2	26.3
Creatinine	500	2.8	18.7	31.2
Ethanol	1000	2.1	19.1	31.6
Galactose	10	1.3	19.3	31.5
γ-Globulin	500	0.5	17.9	32.5
Glucose	1500	1.8	19.4	31.0
Hemoglobin	300	2.6	20.3	32.3
Human Serum Albumin	500	2.3	20.4	33.1
Oxalic Acid	100	1.5	19.7	30.1
Riboflavin	0.25	1.1	18.7	33.6
Sodium Chloride	2000	0.0	15.1	27.4
Urea	2000	0.0	18.6	31.1
pH 3	N/A	0.0	17.1	29.2
pH 4	N/A	0.0	15.0	27.6
pH 5	N/A	0.0	15.0	26.9
pH 6	N/A	0.0	17.2	29.1
pH 7	N/A	0.3	17.2	32.2
pH 8	N/A	0.0	19.2	33.8
pH 9	N/A	0.9	20.0	32.5
pH 10	N/A	1.1	19.2	32.9
pH 11	N/A	3.1	21.5	36.9

**Specific Gravity:** Samples ranging in specific gravity from 1.002 to 1.025 were tested with the assay in the presence of 0 ng/mL, 18.75 ng/mL and 31.25 ng/mL (positive and negative controls for THC 25) of cTHC, and no interference was observed.

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Additions, deletions, or changes are indicated by a change bar in the margin.  
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