“Sugars”: The chemical characterization of a prevalent illicit drug cocktail in South Africa

By

YVETTE Y. CHETTY

Submitted in fulfilment of the Degree of Master of Medical Science

In the

Discipline of Physiology

School of Laboratory Medicine and Medical Sciences

College of Health Sciences

University of KwaZulu-Natal

Durban, South Africa

2016

DECLARATION

This study represents original work by the author and has not been submitted in any other form to another university. Where use was made of work published by others, it has been appropriately acknowledged.

I empower the University of KwaZulu-Natal to reproduce for the purpose of research either the whole or any part of the content in any manner whatsoever.

The research described in this dissertation was supervised by:

Dr A. Nadar
Department of Physiology
School of Laboratory Medicine and Medical Sciences
College of Health Sciences
University of KwaZulu-Natal
Durban, South Africa

and

Dr P. Naidoo
Discipline of Pharmaceutical Sciences
School of Health Sciences
College of Health Sciences
University of KwaZulu-Natal
Durban, South Africa

Yvette Y. Chetty	2 March 2017 Date
Dr A. Nadar	Date
Dr P. Naidoo	Date

DEDICATION

In memory of my mother

"She made broken look beautiful
and strong look invincible. She walked with
the universe on her shoulders and made it look
like a pair of wings."
– Ariana Dancu

ACKNOWLEDGEMENTS

"No man becomes great on his own. No woman becomes great on her own.

The people around them help to make them great." - Unknown

I wish to place on record my sincere appreciation to:

- ♥ My family for their encouragement and support which enabled me to reach this academic milestone. I value all the input you have made thus far to my academic endeavours.
- ♥ My supervisor, Dr Anand Nadar, Department of Human Physiology (UKZN) and co-supervisor, Dr Panjasaram Naidoo, Discipline of Pharmaceutical Sciences (UKZN) for their patience, understanding and continuous motivation to strive for success.
- ♥ Mr Sam Pillay and Shantal Bechoo, Chatsworth Anti-Drug Forum, for their assistance in the acquisition of the drug samples.
- ♥ Professor Thavendren Govender and Dr Tricia Naicker, Catalysis and Peptide Research Unit (UKZN), for patiently teaching me the various pharmaceutical analysis techniques utilized in this work.
- ♥ Staff from the Department of Human Physiology and Department of Pharmacy, UKZN, for all their kind assistance in making this work possible.
- ♥ My postgraduate friends from various departments at the University of KwaZulu-Natal, for always giving solid academic advice and for assistance offered towards this work.
- ♥ Mrs H Govender, Department of Chemistry (UKZN), for her guidance and academic advice.
- ♥ Mrs Lelika Lazarus, Department of Clinical Anatomy (UKZN), for always having my best interests at heart, and for ensuring that I never lacked the affection of a mother.
- ♥ College of Health Sciences (UKZN) and National Research Foundation (NRF) for the financial assistance provided, that enabled the successful completion of this work.

TABLE OF CONTENTS

LIST OF FIGURES

Chapter 1

Chapter 2

Chapter 3

LIST OF TABLES

Chapter 2

LIST OF ABBREVIATIONS

CNS	Central nervous system
CRH	Corticotrophin releasing hormone
GABA	Gamma-Aminobutyric acid
LC-MS	Liquid Chromatography-Mass Spectroscopy
NMR	Nuclear magnetic resonance imaging
PNS	Peripheral nervous system
POMC	Precursor protein proopiomelanocortin
TLC	Thin layer chromatography

ABSTRACT

Introduction

"Sugars" is an illicit drug cocktail that is thought to be a mixture of heroin, cocaine and other substances in order to add bulk to the final product. Since its emergence in a local KwaZulu-Natal community known as Chatsworth in 2006, the use of the drug has spread to other provinces in South Africa and has currently become a popular drug amongst the youth. The affordability of the cocktail has allowed it to become rampant in low income communities and this coupled with its accessibility further reinforces "Sugars" as the preferred drug of choice. The use of the drug allows the user to experience euphoria, however once the effects wear off, the pain of the resulting withdrawal or "roster" drives the individual to continue using the drug. The withdrawal symptoms range from common cold and flu-like symptoms to extreme bone pain, stomach cramps, constipation and nausea. There have been attempts at rehabilitating "Sugars" addicts however, due to the lack of knowledge of a precise chemical composition of the cocktail, it is difficult to effectively maintain therapeutic interventions.

Aim

The aim of this study was therefore to chemically characterize the composition of "Sugars", thereby allowing for the development of targeted treatment options for rehabilitation centres.

Method

Batches of samples of the mixture were sourced from 3 independent suppliers in the Durban South area of KwaZulu-Natal, South Africa. Chromatographic techniques were used to separate the individual constituents of the mixture and determine molecular weights of these compounds. Nuclear magnetic imaging was used to identify the compounds.

Results and discussion

The tests confirmed the presence of heroin, papaverine and noscapine in the "Sugars" samples analysed. However, there was variance noted in the composition between the different sources of the drug. We hypothesize that "Sugars" was therefore not heroin that is bulked up with other substances, but may be the waste product of the final purification process in the illicit heroin manufacturing process.

Conclusion

It was concluded that “Sugars” contained heroin, noscapine and papaverine. The variance in composition of heroin in the samples suggests independence between suppliers. The presence of papaverine and noscapine, which are impurities that are usually removed during the final purification of heroin, supports the hypothesis that “Sugars” is the waste product of the manufacture of heroin. Noscapine and papaverine are costly pharmaceutical products and we therefore speculate that it would not be economically viable to bulk up a cheap low grade drug cocktail with these compounds.

EPIGRAPH

"*"One day you love me, the next day you hate*

But you never resist the hook and bait

You cry for escape, but what do I care?

The net that I cast is a permanent snare

Mickey furrowed his brow. "I don't get it. This is about cravings or something."

"Close." Francisco took back the riddle and wrote a word on the back: "Addiction."*"*

Why is God laughing? The path to joy and spiritual optimism - Deepak Chopra

CHAPTER 1

INTRODUCTION

1.1 Background and literature review

"Sugars" is the street name given to a local drug cocktail that has recently become popular amongst South African youth. It has been described as a "mixture of residual heroin and cocaine" to which other general substances are added to give bulk to the end product and is thought to be packaged in refuse plastic bags that is shaped in a loop [1]. The addicts tend to inhale the vapour using a straw or empty pen after burning the drug on a piece of aluminium foil, which is a method of use also common in heroin users known as "chasing the dragon" [2]. The addicts experience euphoria after using the drug however this is quickly followed by withdrawal symptoms which occur approximately 4 hours after the last use of the drug. The withdrawal or "roster" is thought to include severe body pain, cravings, lack of concentration, sweating, goose bumps, and hot flushes as well as watery eyes and constipation [1].

"Sugars" was first introduced into a Durban suburb known as Chatsworth [3] and as such one has to first understand the socio-economic dynamics of the area and substance abuse history of the inhabitants which allowed Chatsworth to be the ideal breeding ground for the debut of this deadly concoction.

"Sugars" and its influx into Chatsworth

Chatsworth was a predominantly Indian community in the 1960s due to the forced relocation of Indian people from other areas in Durban. This was in accordance with the Group Areas Act that was passed in 1950 by the Apartheid government which resulted in the segregation of racial groups into designated residential areas. The 1970s and 1980s saw the rise of 'shebeens' or bars to allow adult men to socialize and the younger generation of men being drawn into illegal activities that resulted from joining emerging gangs in Chatsworth in lieu of other forms of entertainment that were situated in the Central Business District of Durban [3]. It was in this gang formation network that the marketing of Mandrax occurred in Chatsworth in the early 1980's. Mandrax made its entry into the Chatsworth community via South African Indians that smuggled it back with them from trips to India[3]. The Chatsworth drug lords during the 80s established strong community ties and as such people were willing to hide the drugs and allow their sons to work for the drug lords. The drug trade therefore expanded and the drug lords began to delve into other drugs such as rock and ecstasy as well as widen their network by supplying other areas in Durban[3].

The rise of a local drug lord, Gonnie was largely due to Mandrax. However, his reluctance to start dealing with "Sugars" may have led to his untimely death in December 2006, thought to be orchestrated by one of his junior members who introduced "Sugars" to the Chatsworth community and thereafter acquired a monopoly over the trading of "Sugars" in Chatsworth. A specialized police unit considered a local drug den, Dalton Hostel, to be the source of "Sugars" and attributed the drug influx into Chatsworth to taxi drivers, as well as identifying primarily Tanzanian and Zanzibaris as the individuals that assert control over the "Sugars" trade [4].

The "Sugars" addict

The available literature that focuses on "Sugars" and its effects have been primarily written from a psychosocial perspective and interviews with addicts, recovering addicts or their caregivers and family members, have all formed an important foundation in gauging the detrimental effects of this drug in a social context. The drug which is believed to be a mix of residual heroin and cocaine mixed with other substances ranging from rat poison to baking powder has a powerful withdrawal to re-engage and maintain the users addiction [1]. The increased use of drugs can be attributed to factors such as its affordability, availability and accessibility [5]. Psychosocial research has suggested that "Sugars" seems to have met all the above-listed criteria [1, 3, 5].

A leader of the Anti-Drug Forum in Chatsworth noted that the youth were greatly affected, as a large proportion of the patients that approached the clinic were aged between 12 and 24 and addicted to "Sugars" [5]. The temptation to relapse can be attributed to the drugs availability in the community as well as its highly addictive characteristics [4]. Although the true chemical make-up of the drug has not been assessed, an addict has reported in a previous study that he was aware that the drug dealer mixed various substances to form "Sugars" [5]. These various substances could possibly be the reason that the withdrawal symptoms are so unbearable to addicts, however another study points to the fact that the effects of "Sugars" are similar to that of heroin and likens the plight of addicted youth to symptoms experienced by heroin users in India in the 1980s [6].

The family members of addicts, specifically their parents, took varying approaches to rehabilitate their addicted offspring. Some parents offered a support structure and encouraged enrolment in rehabilitation centres, whereas others responded by physically abusing the addicted youth and in some cases, parents have also been affected by the violent outbursts of their addicted children [4]. An interview with the sister of an addict in a study by Singh [5], sheds perspective on the plight of addicts and the effects of their addiction on their families. The interviewee describes in detail how her brother, who was addicted to "Sugars" for approximately 3 years, stole items from the family home including their gate, to support his habit before

his family 'kicked him out'. She added that on the street, her brother resorted to begging in order to get his next fix and a bit of food to sustain himself. This highlights the extent that the drug addicts will go to in order to relieve the "roster". Another addict in the same study, described how he suffered from diarrhoea, extreme sweats and paranoia if he did not use the drug timeously, and also admitting to stealing if necessary to buy the drug [5].

"Sugars" in the broad South African context

In April 2006, the introduction of "Sugars" in Durban and the turmoil that was left in its wake was exposed in media publications. Various accounts of the effects of "Sugars" were noted and addicts were reported to have resorted to stealing and even prostitution to support their habit [7]. The reasons for using the drug ranged from boredom to personal problems and police believed that the influx of "Sugars" into Chatsworth started around 1999 which is supported by addicts admitting to several years of addiction to "Sugars" in media reports [7]. The article also reported the excruciating pain that addicts experience during their withdrawal or "roster" which also included cravings, lack of concentration, constipation and sweating amongst other symptoms.

As early as June 2006, the media began reporting that the "Sugars" craze has crept into other provinces in South Africa [8]. Although initially being a problem in the Indian communities of Chatsworth and Phoenix, a local ministry also interviewed for the above article, received numerous phone calls from concerned parents from Johannesburg and Cape Town amongst other areas that reported their children experiencing similar symptoms to that of "Sugars" addicts in KwaZulu-Natal, after the organization created televised awareness on "Sugars".

"Sugars", "Whoonga", "Nyaope"- is it a case of "A rose by any other name would smell as 'sweet'"?*

Four years after the initial media hype over "Sugars", the lure of the drug had not waned. A blog post suggested that the severity of the situation had escalated and the age of individuals becoming embroiled in "Sugars" addiction was getting lower: "Girls, as young as 15 can be seen on the roads, … They discard their chastity for as little as the cost of a fix – about R20 to R50." [9].

Another media publication suggested that "Sugars" is now known as "Whoonga" on the street, a statement that is corroborated by an ex-dealer interviewed for the same article [10]. "Whoonga" is thought to contain anti-retroviral medication, however, police suggest that heroin is the primary ingredient and other substances are added to the mixture [10]. An analysis of "Whoonga" by Prof. T. Govender of the University of KwaZulu-Natal, did not correlate with media speculation and revealed the presence of heroin, morphine and strychnine in the sample [11]. There is currently no empirical evidence that can pinpoint the exact

ingredients of "Sugars" in order to investigate the relation between "Whoonga" and "Sugars", however the reliability of analysis conducted on a single sample is questionable, in light of media speculation on the great variation of the content of these mixtures.

* a line adapted from the play "Romeo and Juliet" [12]

Neurophysiological and psychological aspects of addiction

Addiction can be described as habit that is compulsively sustained regardless of its negative consequences [13]. Addictive behaviour can be divided into three stages viz. preoccupation, compulsion and relapse [14]. The addict develops an urgency to obtain the drug in the preoccupation stage, often at the expense of individual obligations and social interactions. The use of the drug becomes compulsive and the individual continues with drug use despite negative personal and social side effects. In the event that the addict attempts to break the addictive cycle, the negative effects experienced in the compulsion stage may encourage re-use of the drug. This cycle however only explains partially the phenomenon of addiction and as aptly stated by Donovan and Marlatt [15], addiction is a "complex, progressive behaviour pattern having biological, psychological, sociological and behavioural components".

Physiological stress results in hypothalamic release of corticotrophin releasing hormone (CRH). CRH leads to the secretion of precursor protein proopiomelanocortin (POMC) from the pituitary gland which increases the concentration of beta-endorphins. An excess of POMC products results in a negative feedback loop that leads to inhibition of hypothalamic release of CRH [16]. In the peripheral nervous system (PNS), beta-endorphins produce analgesic effects by binding to opioid receptors, usually mu-receptors, at either the pre- or post-synaptic terminals. Beta-endorphins have similar actions as morphine and are involved in pain pathways and in innate reward systems [17]. The binding of beta-endorphins results in a series of reactions that reduce the release of tachykinins such as substance P, which has a role in the transmission of pain [18-20]. In the central nervous system (CNS), beta-endorphins also bind to mu-receptors at either pre- or post-synaptic terminals however the cascade of events that follows binding results in the inhibition of GABA instead of substance P [18, 20]. This inhibition of GABA leads to an increase in dopamine, which plays a role in the sensation of pleasure.

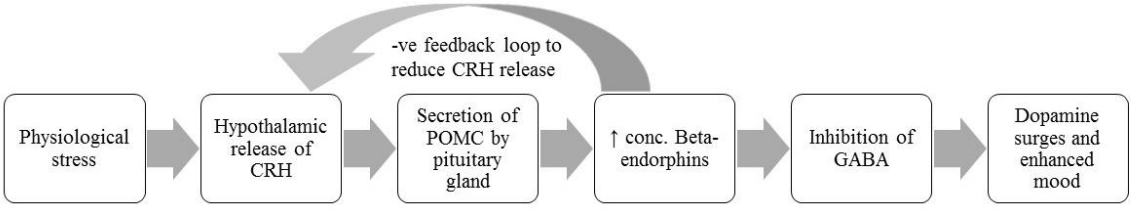

Figure 1. Diagramatic represention of dopamine pathway

Current treatment available for "Sugars"

The initial treatment available for "Sugars" addiction was treatment with Subutex®, which has a high affinity for the mu receptor where it acts as a partial agonist and also reduces the effects of additional opioid use [21]. The dose of Subutex® is calculated using the amount of "Sugars" smoked by the individual per day and as such requires honest and accurate details of the daily consumption of the drug from the user in order to be effective [1]. The Chatsworth Youth Centre provides Subutex® treatment however their rehabilitation program also incorporates meditation, yoga and counselling sessions. Subutex® has now been replaced by Suboxone® which also contains a morphine antagonist known as naloxone. This combination of a partial agonist and an antagonist has shown promising effects when administered together with counselling and medical detoxification [4]. Singh [5] acknowledges the positive contribution that the will power of the addict combined with motivation from an extended support system can produce in rehabilitating individuals, however, the end result has not always been successful rehabilitation and as such targeted therapy strategies together with the above measures are necessary.

1.2 Research problem and clinical significance

Although there are several studies that have explored the psychosocial effects of "Sugars", there is a lack of analytical evidence to identify the chemical composition and signature of this low grade mixture. The available literature suggests that the drug contains heroin which is mixed with other substances to add bulk to the final product [1, 5]. The treatment for "Sugars" addiction thus targets heroin and its receptors and does not focus on the other ingredients in the mixture which could also possibly be responsible for the addictive nature of "Sugars". This study therefore serves to chemically analyse "Sugars" in order to provide an accurate account of what the drug contains which will allow for the development of targeted therapies to combat "Sugars" addiction.

1.3 Purpose of the study

The purpose of the current study was therefore to:

i. To determine the constituents of the drug cocktail so as to ensure effective treatment
ii. Identify the ingredients which may provide an indication of the origin of "Sugars". This can be used to determine the route of entry into the country if the drug or its constituents are imported
iii. Determine if variation exists between samples. The active ingredient can therefore be determined using an animal model and targeted therapies can be developed.

1.4 Aims of the study

The aim of this study was to chemically characterize the illicit drug mixture into its individual constituents.

1.5 Objectives of the study

The objectives of this study were:

i. To obtain samples of the illicit drug cocktail from three different areas in the Durban South region, KwaZulu-Natal
ii. To chemically separate the mixture into its individual constituents
iii. To identify the individual constituents in the mixture
iv. To adequately quantify their percent composition in the mixture
v. To determine if variation of constituents and their percent contribution to the mixture occurs between samples obtained from different areas in the Durban South region, KwaZulu-Natal

1.6 Methodology

1.6.1 Acquiring of samples

Three sample sets of "Sugars" were obtained from three areas in the Durban South region, South Africa. The "Sugars" were packaged into individual green plastic straws, each a few centimetres in length. Samples were obtained via a drug addiction rehabilitation organization in the Durban South region. Permission was granted by the Minister of Health to acquire, purchase and use the samples for research (Permit number: POS 290/2015/2016).

1.6.2 Liquid Chromatography – Mass Spectroscopy (LC-MS)

a) Crude sample analysis

The straws were grouped according to site of origin and labelled to reflect their independent areas of origin (A, B or C). An aliquot was prepared for LC-MS analysis by dissolving a small amount (<1g) of each pooled sample in HPLC grade (Merck Millipore, Midrand, SA) acetonitrile (1mL) and deionized water (0.5mL). Undissolved particles were removed via filtration using syringe filters and a Shimadzu 2020 UFLC-MS with a YMC-Triart C18 (5µm, 4.6 x 150mm) column was used to conduct analysis. The results were read at 220nm and LabSolution software (Version) was used to analyse data.

b) Analysis of isolated compounds

Following column separation, the isolated compounds underwent the same process as the pooled sample prior to LC-MS analysis. A Shimadiz 2020 UFLC-MS with a YMC-Triart C18 (5µm, 4.6 x 150mm) column was used. LC-MS results were read at 220nm and interpreted using LabSolution software.

1.6.3 Column chromatography

A silica gel column was used to separate the "Sugars" samples into their individual constituents. The samples were loaded undiluted onto the column. A solvent system of hexane and ethyl acetate (Merck Millipore, Midrand, SA) was used in the ratio 50:50 as the eluent. Fractions of eluent were collected in test tubes and were spotted on silica gel 60 F254 25 aluminium sheets (Merck Millipore, Midrand, SA). Thin layer chromatography (TLC) was used to assess the independence of fractions eluted. Common fractions were collected in round bottom flasks and dried at 40 ^{o}C using a rotary evaporator to remove excess solvent. The mass of the extracted compounds were noted and equation 1 was used to calculate percent composition.

Equation 1

$$\frac{\text{Mass of extract}}{\text{Mass of sample}} \times 100$$

1.6.4 Nuclear Magnetic Resonance imaging (NMR)

Individual compounds (~10mg) were dissolved in 0.5ml $CDCl_3$ solution. NMR spectra were recorded using a Bruker AVANCE III 400 MHz at room temperature. Chemical shifts were expressed in ppm.

1.7 Structure of dissertation

This thesis is structured as follows:

Chapter 1

- Background and literature review
- Research problem and clinical significance
- Purpose of the study
- Aims of the study
- Objectives of study
- Methodology

Chapter 2

This chapter contains the manuscript titled: **The use of chromatographic techniques to chemically analyse an addictive illicit drug "Sugars"** submitted to South African Journal of Science (Manuscript ID: SAJS-2016-0324).

Chapter 3

This chapter discusses the findings presented in the manuscript presented in Chapter 2 and explores:

- the limitations of the current study
- further research that may advance this study
- and conclusion of findings

REFERENCES

1. Pattundeen G. Missing out on migration:“Sugars” and the Post-Apartheid Youth of Chatsworth. Special Edition. *Journal of Social Sciences*. 2008; 10: 61-71.

2. Strang J, Griffiths P and Gossop M. Heroin smoking by 'chasing the dragon': origins and history. *Addiction (Abingdon, England)*. 1997; 92: 673-83; discussion 85-95.

3. Desai A. Between the Lahnees and the Lightees: Chatsworth's Underworld. *The Oriental Anthropologist*. 2012; 12: 319.

4. Jagganath G. The Bitter Reality of" Sugars" and the Youth of Chatsworth. *Oriental Anthropologists*. 2012; 12.

5. Singh SB. " Ganja to Sugars": The History of substance abuse by Indian Youth in the working class township of Chatsworth, Durban. *The Oriental Anthropologist*. 2012; 12: 349.

6. Singh A and Singh S. The history of crime among people of Indian origin in South Africa. *Anthropologist*. 2006; 8: 147-56.

7. Tolsi N. Durban hit by 'sugars' rush. Mail&Guardian AFRICA'S BEST READ2006.

8. Kuppan I. Sugars drug spreads to other provinces. 2006.

9. The Drug Despair in Durban. 2010.

10. Boomgaard M. Whoonga whammy. *IOL News*. 2010.

11. News H-e. Whoonga dealers are 'peddling poison'. *Witness*. South Africa2011.

12. Shakespeare W. *romeo and juliet*. Lippincott, 1913.

13. Wise RA. Brain reward circuitry: insights from unsensed incentives. *Neuron*. 2002; 36: 229-40.

14. Miller NS. *Addiction Psychiatry: Current Diagnosis and Treatment*. Wiley, 1995.

15. Donovan DM and Marlatt G. *Assessment of addictive behaviors*. Guilford Press, 1988.

16. Calogero AE, Gallucci WT, Gold PW and Chrousos GP. Multiple feedback regulatory loops upon rat hypothalamic corticotropin-releasing hormone secretion. Potential clinical implications. *Journal of Clinical Investigation*. 1988; 82: 767.

17. Koob GF. Drugs of abuse: anatomy, pharmacology and function of reward pathways. *Trends in pharmacological sciences*. 1992; 13: 177-84.

18. Brunton L, Lazo J and Parker K. *Goodman & Gilman's The Pharmacological Basis of Therapeutics, Eleventh Edition*. McGraw-Hill Education, 2005.

19. Epstein FH and Stein C. The control of pain in peripheral tissue by opioids. *New England Journal of Medicine*. 1995; 332: 1685-90.

20. Miller RD. *Miller's Anesthesia*. Elsevier Science Health Science Division, 2005.

21. Whelan PJ and Remski K. Buprenorphine vs methadone treatment: A review of evidence in both developed and developing worlds. *Journal of Neurosciences in Rural Practice*. 2012; 3: 45-50.

CHAPTER 2

The use of chromatographic techniques to chemically analyse an addictive illicit drug "Sugars"

Presented according to author guidelines of SOUTH AFRICAN JOURNAL OF SCIENCE

Submitted to the Editor on 25 October 2016

(Manuscript ID: SAJS-2016-0324)

Title: The use of chromatographic techniques to chemically analyse an addictive illicit drug “Sugars”

Short title: The characterization of an illicit drug cocktail in South Africa

Authors: Yvette Y. Chetty[1], Panjasaram Naidoo[2], Anand Nadar[1]

Name of Institution:
[1]Department of Physiology
School of Laboratory Medicine and Medical Science
College of Health Sciences
University of KwaZulu-Natal
Westville Campus
Private Bag X54001
Durban
South Africa
4000

[2]Discipline of Pharmaceutical Sciences
School of Health Science
College of Health Sciences
University of KwaZulu-Natal
Westville Campus
Private Bag X54001
Durban
South Africa
4000

Corresponding author: Yvette Chetty
Department of Physiology
School of Laboratory Medicine and Medical Sciences
College of Health Sciences
University of KwaZulu-Natal
Private Bag X54001
Durban
4000
South Africa

Telephone: 0730979660

E-mail: yvettechetty@ymail.com

Key words : “Sugars”, heroin, illicit cocktail, South African, addiction

ABSTRACT

Background

Sugars is the street name given to a highly addictive drug cocktail that has recently become a scourge amongst South African youth. This affordable and easily accessible mixture, is alleged to have several other street names in order to interfere with the efficacy of investigations on this mixture by legal authorities. Anecdotal evidence emanating from psychosocial studies conducted on individuals addicted to this mixture, suggests that the mixture is highly variable and possibly contains heroin, cocaine and rat poison among other substances. However, there is a lack of comprehensive chemical analysis on a sample of this mixture to validate this information.

Aim

The aim of this study therefore was to generate empirical evidence to chemically validate the composition of this cocktail by characterising and quantifying the components of the drug mixture.

Methods

Samples were obtained from 3 independent suppliers in the Durban South region, South Africa after obtaining a permit from the National Department of Health to acquire, possess and use the substance for research purposes. The samples were analysed using chromatographic techniques and nuclear magnetic resonance imaging.

Results

The results indicated that there is great variance between samples from different suppliers of the mixture with heroin emerging as a common ingredient. The other compounds identified were opium derivatives and by-products of the heroin manufacturing process.

Conclusion/Importance

These results suggest that “Sugars” may be the waste product of an illicit heroin manufacturing process rather than a low grade mixture of residue heroin.

Keywords

“Sugars”, heroin, illicit cocktail, South African, addiction

Text

Introduction

Addiction as described by Avena *et al* [1], is "a pattern of compulsive, uncontrollable behaviours that occur at the expense of most other activities and intensify with repeated cycles". Pickard [2] states that the actions of an addicted individual sustains the addiction and actions such as strong or habitual desire, willpower, motivation, the function of the drug in the person's life and decision and resolve play crucial roles in the process. The popular theory of addictive behaviour in a neurobiological context is the stimulation of the dopaminergic reward pathway. The use of narcotic substances initially boosts dopamine levels above normal physiological levels which allows for the activation of the direct striatal pathway using D1 receptors and inhibits the indirect striato-cortical pathway using D2 receptors [3]. Neuroplastic changes in the glutamatergic stimulation of the midbrain and striatum dopamine neurons occur following repeated use of the drug [3]. Wise [4] states that the pathway associated with reward-based stimulus, projects from the ventral tegmental area to the nucleus accumbens via dopamine neurons. The chronic use of drugs allows the brain to be more receptive to rewards from drug use rather than non-drug related activities, in effect limiting the restraint of the individual as they become more susceptible to stressful environmental stimuli [3].

The stress of daily life can be experienced in many ways but living in poor economic conditions is a reality to many South Africans [5]. The political and socioeconomic transition of the country has played a key role in the lifestyle choices of its citizens and it appears that many South African youth have resorted to drugs as an escape [6]. Over the years, the choice of drug has varied but an emerging extremely addictive mixture of heroin has become a scourge in South African communities [7, 8].

"Sugars" is the street name given to this highly addictive low grade heroin based drug cocktail and anecdotal evidence obtained from psychosocial studies suggests that other substances are added to it to increase the mass of the final product [8]. It is a readily available and affordable drug mixture that has become prevalent in South Africa. The addicted individuals experience a sense of euphoria upon smoking the drug, however this 'high' only lasts approximately 4 hours [8]. Social studies conducted by Pattundeen [8] on addicts using this mixture, found that they described the withdrawal or 'roster' as having watery eyes, a runny nose, hot flushes, cold sweats, severe body pain including stomach cramps and joint pain, constipation, intense cravings and loss of concentration. The withdrawal is reported to be severe and addicts that do not have funds readily

available to support their habit, may resort to criminal activities such as prostitution and stealing in order to buy the drug and relieve their symptoms [8]. Recent media reports have suggested that the use of several names, such as “Whoonga”, have been used for the mixture, presumably to confuse legal authorities [9].

These studies were essential in identifying the effects of the drug in addicts however, no studies have been published to date that could provide empirical evidence to quantify the contents of this cocktail. This emerging drug mixture of questionable composition has therefore not been quantifiably analysed and it was therefore beneficial to conduct an analysis to adequately quantify and compare the make-up of this cocktail. This study served to analyse the addictive mixture called “Sugars”, its composition and variance in the Durban South area, KwaZulu-Natal, South Africa.

Materials and Methods

Acquisition of samples

Three batches of the drug sold under the street name “Sugars”, were obtained from three different areas that have been associated with easy accessibility of the drug in the Durban South region, South Africa. Samples were packaged in green plastic straws that were a few centimetres in length and sealed at both ends. The samples were obtained via a drug addiction rehabilitation organization in the Durban South region. Permission was obtained to acquire, purchase and use the samples for research purposes from the Department of Health (Permit number: POS 290/2015/2016).

Column chromatography

Column chromatography was used to separate the mixture into its constituents. Undiluted samples were loaded onto a silica gel column. A solvent system of hexane and ethyl acetate (Merck Millipore, Midrand, SA) was used in the ratio 50:50 as the eluent. Fractions of eluent (5mL) were collected in test tubes and were spotted on silica gel 60 F254 25 aluminium sheets (Merck Millipore, Midrand, SA) for thin layer chromatography that was conducted to differentiate between fractions. Thin layer chromatography(TLC) was used to monitor the extraction of independent fractions. Common fractions were pooled and emptied into round bottom flasks. The fractions were dried at 40 ^{o}C using a rotary evaporator to remove excess solvent. The masses of the

extracted compounds were noted and the percent composition was calculated using the following equation: $\frac{Mass\ of\ extract}{Mass\ of\ sample}\ X\ 100$

Liquid Chromatography – Mass Spectroscopy (LC-MS)

a) Crude sample analysis

Samples were pooled according to the area they were sourced from (A, B or C) and a small amount (<1g) from each sample area was placed in standard LC-MS vials. Samples were dissolved using 1mL of acetonitrile and 0.5mL deionized water. The solution was filtered to remove any undissolved particles and LC-MS was conducted using a Shimadzu 2020 UFLC-MS with a YMC-Triart C18 (5µm, 4.6 x 150mm) column. LC-MS was read at 220nm and data was analysed using LabSolution software.

b) Analysis of isolated compounds

The individual compounds isolated from column separation of samples were placed in LC-MS vials and dissolved in acetonitrile (1mL) and water (0.5mL). Samples were then filtered to remove any insoluble particles. Compounds were run on a Shimadiz 2020 UFLC-MS with a YMC-Triart C18 (5µm, 4.6 x 150mm) column. Data was interpreted using LabSolution software. LC-MS results were read at 220nm.

Nuclear Magnetic Resonance (NMR) imaging

Individual compounds (~10mg) were dissolved in 0.5ml $CDCl_3$ solution. NMR spectra were recorded using a Bruker AVANCE III 400 MH_z at room temperature. Chemical shifts were expressed in ppm.

Results

Column chromatography

The samples were weighed out as follows: 0.1834g of Sample A, 0.2151g of Sample B and 0.26g of Sample C. The percent composition was calculated according to the masses above. Each sample was run individually on a column. Sample A was separated into 7 compounds, Sample B into 2 and Sample C into 2. Independent fractions of each compound were extracted from the silica gel column and dried at 40 ^oC using a rotary evaporator to remove the solvent solution.

Liquid Chromatography – Mass Spectroscopy (LC-MS)

a) Crude sample analysis

The retention times obtained after analysis of crude samples varied between 13.1 and 15.7 seconds. Table 1 shows the retention times obtained for each sample pooled according to its area.

b) Analysis of isolated compounds

LC-MS was conducted on the isolated compounds to determine their molecular weights. Some compounds were unable to be identified due to minimal quantities being present in the sample however molecular weights of compounds that were successfully detected are reported in Table 2. The constituents that are not mentioned were those that were present in minor quantities and their retention times and molecular masses were undetectable.

Nuclear Magnetic Resonance (NMR) imaging

NMR analysis was conducted to verify the identity of the compounds. The NMR spectra obtained suggested that the peaks of the compounds isolated, match the reported literature NMR spectra of heroin, papaverine and noscapine obtained from Scifinder®.

Percent composition

Sample A contained minimal concentrations of heroin (<1%) whereas Sample B contained 30.26% heroin and 3.49 % papaverine. Sample C contained 99% noscapine and a minimal concentration of heroin (<1%). Heroin was hence considered to be the common ingredient of the drug cocktail. The other compounds that were isolated were not present in quantities that allowed for effective identification using the chromatographic techniques used in this paper.

Discussion

The drug cocktail was easily obtainable from the areas selected in the Durban South region of KwaZulu-Natal. The drug was packaged in green plastic straws of variable lengths, that were sealed on both ends and the contents thereof varied in colour from white to brown between suppliers. Previous studies that analysed illicit samples of heroin suggest that the colour of heroin varies between countries and could therefore be used an as indication of its origin [10]. The samples were pooled according to the area it was obtained from and thereafter chemically characterized.

Although there is much speculation on the composition of the cocktail, the results of the chemical analyses showed that heroin was present in all samples however the percent present in each sample varied. This chemical difference coupled with the variations in colour suggests independence between the suppliers.

Heroin can either be created by acetylation of morphine in a pharmaceutical environment or by purifying opium to yield morphine and thereafter produce heroin. The latter is the illicit method of producing heroin and can possibly result in impurities such as papaverine and noscapine [10-12].

The manufacturing of heroin is considered illegal and the availability of a general published method for the illicit synthesis of heroin is therefore rare. Zerell, Ahrens [11] described the manufacturing process in their research article which documented the production of heroin in Afghanistan. The process was carried out by two Afghanistan nationals. Hot water, calcium oxide and ammonium chloride were added to the raw opium to form a morphine base. Acetic anhydride and sodium carbonate were used to produce a brown heroin base from the morphine base. The brown heroin base was subsequently treated with hydrochloric acid, activated carbon and ammonia solution to form a white heroin base which is further refined to white heroin hydrochloride using acetone or hydrochloric acid.

The “Sugars” samples analysed in this study showed low quantities of heroin in two sources, with the third source having a heroin concentration of just over 30 %. This suggests variance between suppliers and due to the presence of noscapine and papaverine which are otherwise removed during the manufacturing process, the authors postulate that “Sugars” could be the waste product of the conversion of the brown heroin base to the white heroin base in the manufacturing process.

The reported content of papaverine and noscapine in raw dried opium is 3.2 % (range: <0.1 – 9.0 %) and 8.1 % (range:1.4 – 15.8 %) respectively [11]. Analysis of illicit heroin by Zerell, Ahrens [11] has also revealed that papaverine and noscapine are present in the brown heroin base but not the white heroin base or white heroin hydrochloride. Zerell, Ahrens [11] states that raw opium contains between 0.6 – 2.2 % papaverine and 6.8 – 9.8 % narcotine. They have also reported that the morphine base and press cake during the illicit manufacturing process contains 2.4 and 1.2 % papaverine and 20.3 and 3.7 % narcotine respectively. These findings indicate that papaverine and noscapine is present in the steps of the manufacturing process up until the production of the precursive white heroin base and the final product of heroin hydrochloride [11].

Noscapine is a mild analgesic which possesses anti-tussive, anti-mitotic and anti-neoplastic properties[13]. Papaverine is a smooth muscle relaxant and could have some anti-viral properties[13].

Noscapine and papaverine are not well known for their addictive effects but their properties could afford them a secondary role in sustaining the addictive effects of “Sugars” possibly potentiated heroin. Ginzburg [14] describes opioid withdrawal symptoms that range from restless, anxious and craving the drug a few hours after the last use to pain (bone and abdominal), vomiting, weakness, goose bumps and flu-like upper respiratory symptoms approximately 18-24 hours after the last use of the drug. Schnoll [15] states that mixing drugs could lead to antagonistic, additive, synergistic or potentiating the effects of the individual drugs. The withdrawal symptoms associated with “Sugars” as described by Pattundeen [8] suggests that opioids may play a role in both exerting the effects of “Sugars” and stimulating the withdrawal cycle to sustain the addictive pattern. The time taken for the withdrawal symptoms of “Sugars” to occur is thought to be approximately 4 hours which is significantly shorter than the time frame mentioned by Ginzburg [14] for opioids. This suggests that the effects of heroin together with other opioid alkaloids in “Sugars” may have additive or synergistic effects on an individual thus overstimulating the nervous system and reducing the time to withdrawal.

There is media speculation that another drug cocktail called “Whoonga” is the same as “Sugars”, however preliminary analysis of a sample of “Whoonga”; yielded heroin, morphine and strychnine as the ingredients of the drug cocktail [16]. This does not correlate with the results obtained in this study, therefore suggesting that “Whoonga” is a different drug.

Adulterants are those substances that are added after the purification process whereas impurities result from poor preparation technique [12]. The samples analysed in this study did not possess the usual adulterants found in illicit heroin such as quinine, caffeine or strychnine. O'Neil and Pitts [10] suggest that the physical and chemical properties of illicit heroin may provide an indication of its origin. The main countries that have been identified as possible sources of illicit heroin are Pakistan, Nigeria, India, Turkey and South West Asia and it is noted that the purity and contents of the product varies between these countries [10]. This information can provide useful insight for national legal authorities to address illegal drug trading at the borders and ports of their country.

There are three distinct routes for the transit of heroin to different parts of the world known as the Southern route, Balkan route and the Northern route. All routes originate in Afghanistan and end in South East Asia, Western Europe, Caucauses or Africa. It is possible that the properties of the product changes as it moves geographically as there is variation between brown and white heroin seized in Germany. However, it bore similar characteristics to heroin seized in South West Asia and Western Europe [11].

A comparative analysis of heroin from different countries by O'Neil and Pitts [10] revealed that noscapine and papaverine is present in samples obtained from Turkey, Pakistan and some types of heroin from Nigeria and India. This suggests that the heroin used to form “Sugars” could have possibly been imported from one of the abovementioned countries as these impurities would be consistent with that reported by O'Neil and Pitts [10] however there is no current literature available to validate this theory.

Conclusion and Recommendations

In conclusion, it was noted that there is great variation between the samples analysed, which suggests that this low grade heroin mixture is prepared by independent suppliers using ingredients that are easily available to them. This high variability suggests poor preparation technique and inconsistency of the manufacturing process. It is evident that all samples used either heroin or the waste product of the penultimate step in the heroin manufacturing process as the base for the cocktail. The chemical data obtained from the study is not sufficient to conclude which is used, however the easily affordable nature of the drug cocktail substantiates the use of the waste product as the base in the cocktail rather than street heroin. It seems plausible that clandestine chemists would further dilute the waste product rather than purchase papaverine and noscapine to add bulk to street heroin. Media speculation that “Sugars” is the same drug as “Whoonga”, was shown to be false following comparison of data obtained from the preliminary analysis of “Whoonga” which revealed morphine, strychnine and heroin as the main ingredients found in “Whoonga”. Low concentrations of some constituents which prevented identification of all compounds present in the samples, in conjunction with the fact that available literature describes tracing the origin of heroin and shows little interest toward the waste products of the heroin manufacturing process, it is therefore difficult to pinpoint a country of origin of this cocktail.

There is a need to investigate the difference between street heroin and “Sugars”. This can be assessed by comparing the composition of “Sugars” to that of street heroin available from the same supplier to avoid bias. The result of this analysis will reveal the chemical variation, if any, between street heroin and “Sugars” thereby either confirming or refuting the theory presented in this study that “Sugars” may be the waste product of the illicit manufacture of heroin. Further research can be conducted to chemically analyse the waste product from a heroin manufacturing process and assess its similarity to that of “Sugars”. In order to assess variance of the drug cocktail, further studies can conduct a time-line analysis of the mixture from a single supplier on a monthly basis over a suitable period of time. This will allow for monitoring the variance, if any,

of additives to the cocktail over a period of time. A physiological approach to future research on this cocktail would be to investigate the effects of this cocktail and its constituents in an animal model. This will determine if the reported effects are due to an active ingredient in the cocktail or if the compounds present in the cocktail exerts a combined effect.

References

1. Avena NM, Long KA and Hoebel BG. Sugar-dependent rats show enhanced responding for sugar after abstinence: evidence of a sugar deprivation effect. *Physiology & Behavior*. 2005; 84: 359. http://dx.doi.org/10.1016/j.physbeh.2004.12.016

2. Pickard H. The purpose in chronic addiction. *AJOB neuroscience*. 2012; 3: 40-9. http://dx.doi.org/10.1080/21507740.2012.663058

3. Volkow Nora D and Morales M. The Brain on Drugs: From Reward to Addiction. *Cell*. 2015; 162: 712-25. http://dx.doi.org/10.1016/j.cell.2015.07.046

4. Wise RA. Brain reward circuitry: insights from unsensed incentives. *Neuron*. 2002; 36: 229-40. http://dx.doi.org/10.1016/S0896-6273(02)00965-0

5. Nicolson G. South Africa: Where 12 million live in extreme poverty. *Daily Maverick*. south Africa2015.

6. Peltzer K, Ramlagan S, Johnson BD and Phaswana-Mafuya N. Illicit Drug Use and Treatment in South Africa: a review. *Substance use & misuse*. 2010; 45: 2221-43. http://dx.doi.org/10.3109/10826084.2010.481594

7. Balgobind Singh S. " Ganja to Sugars" The History of substance abuse by Indian Youth in the working class township of Chatsworth, Durban. *Oriental Anthropologists*. 2012; 12.

8. Pattundeen G. Missing out on migration:“Sugars” and the Post-Apartheid Youth of Chatsworth. Special Edition. *Journal of Social Sciences*. 2008; 10: 61-71.

9. Boomgaard M. Whoonga whammy. *IOL News*. 2010.

10. O'Neil PJ and Pitts JE. Illicitly Imported Heroin* Products (1984 to 1989): Some Physical and Chemical Features Indicative of Their Origin. *Journal of pharmacy and pharmacology*. 1992; 44: 1-6. http://dx.doi.org/10.1111/j.2042-7158.1992.tb14352.x

11. Zerell U, Ahrens B and Gerz P. Documentation of a heroin manufacturing process in Afghanistan. *Bulletin on narcotics*. 2005; 57: 11-31.

12. Baker P and Gough T. The separation and quantitation of the narcotic components of illicit heroin using reversed-phase high performance liquid chromatography. *Journal of chromatographic science*. 1981; 19: 483-9. http://dx.doi.org/10.1093/chromsci/19.10.483

13. Claus EP and Tyler VE. *Pharmacognosy*. Lea & Febiger, 1965.

14. Ginzburg HM. Naltrexone: Its Clinical Utility. *Controversies in Alcoholism and Substance Abuse*. 1986: 83.

15. Schnoll S. Pharmacological aspects of youth drug abuse. *Youth drug abuse: Problems, issues and treatment Lexington, Mass: Lexington Books*. 1979.

16. News H-e. Whoonga dealers are 'peddling poison'. *Witness*. South Africa 2011.

Acknowledgements

The authors wish to express their sincere gratitude to Dr T. Govender and Dr T. Naicker, Catalysis and Peptide Research Unit, University of KwaZulu-Natal, for their assistance with techniques used in this paper.

The College of Health Sciences, University of KwaZulu-Natal and the National Research Foundation are thanked for their financial assistance provided.

Table 1. Retention times of geographically pooled samples of ‘Sugars’ obtained from LC-MS analysis

Sample	Retention time (minutes)
A	13.1 13.6 14.3 15.7
B	13.1 13.6 14.3
C	13.1 13.6 14.3 15.3

Table 2. Molecular masses of isolated compounds according to retention times

Retention times	Mass (g/mol)
12.8	411
13.2	340
14.2	455
16.8	369

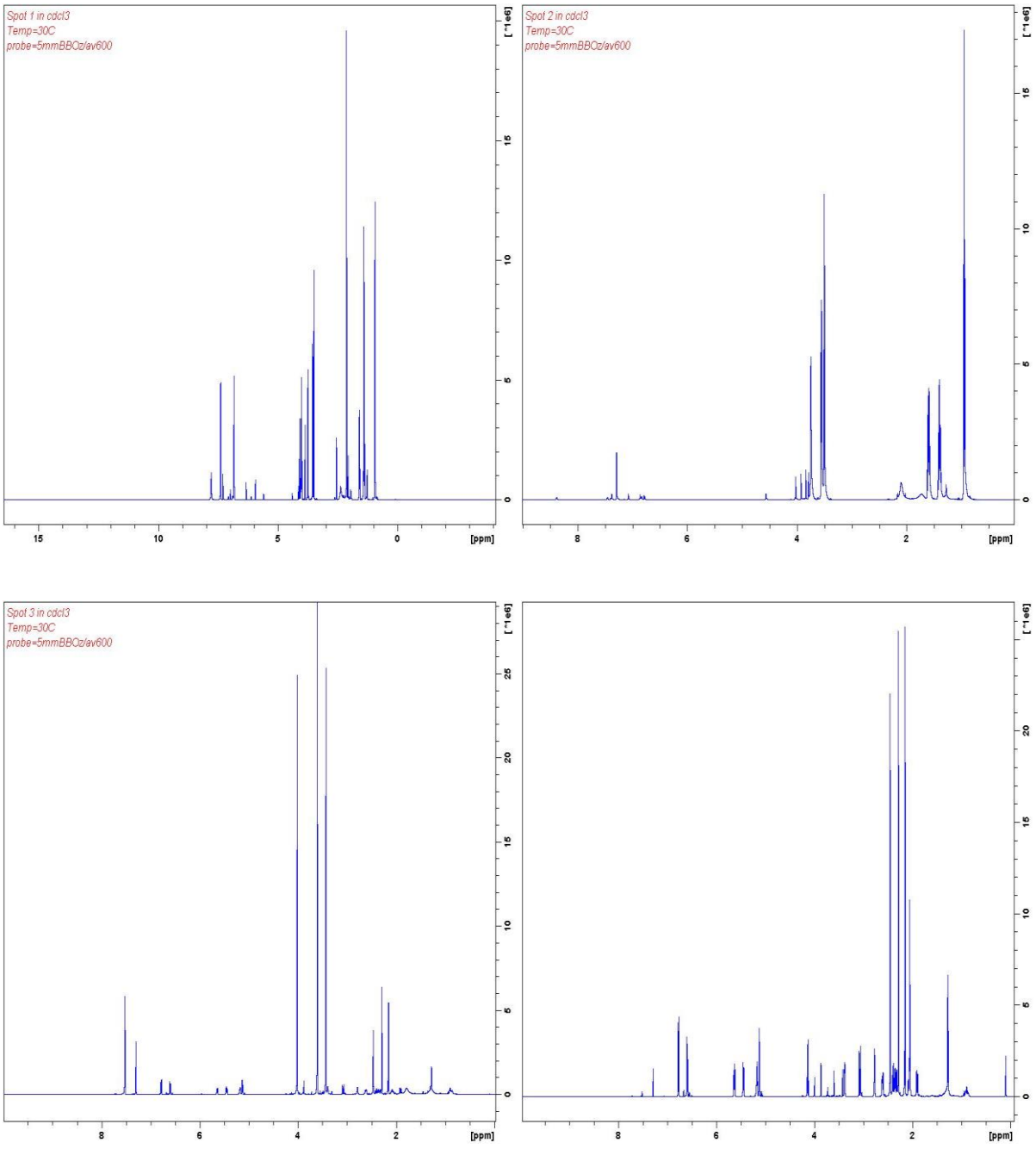

Figure 1. NMR spectra obtained for extracted compounds

CHAPTER 3

SYNTHESIS

3.1 Discussion

The “Sugars” samples were packaged into green plastic straws and little difference was noted in the external appearance of straws from different areas. The contents of the straws were pooled according to their area and a colour difference was observed between pooled samples. The contents varied in colour from white to brown powder. Figure 1 (a) and (b) provides visual examples of the external appearance and the difference in colour between contents respectively. The variance in colour between pooled samples suggests a variation in ingredients of the mixture which indicates there were different independent suppliers. A study by O'Neil and Pitts [1] that analysed illicit heroin obtained from police during drug raids and seizures, suggested that the colour of illicit heroin samples varied and this colour difference may be indicative of its origin. The samples analysed in this study revealed the presence of heroin in all samples analysed and the colour difference of the samples may therefore be attributed to the amount and source of the heroin present in the cocktail. The results of a preliminary study by Prof T Govender of the University of KwaZulu-Natal, which analysed “Whoonga” samples, were compared to the results obtained in this study and there was no common ingredient present other than heroin. “Whoonga” is thought to be a low grade heroin mixture similar in nature to “Sugars” and said to contain anti-retroviral drugs amongst other substances. The analysis proved that it contained strychnine, morphine and heroin with only one sample containing a trace of Stochrine®, which is an ingredient in anti-retroviral drugs[2]. Despite media speculation that suggests “Sugars” and “Whoonga” are the same drug, the results from this study suggests otherwise, as it was found that they only contain heroin as a common ingredient.

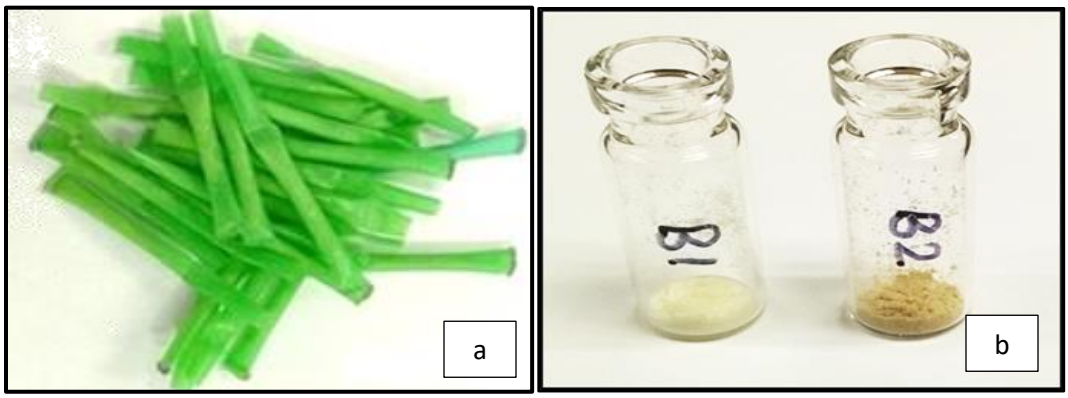

Figure 1. (a) The outer appearance of the “Sugars” straws. (b) The colour variation observed between the contents of the straws.

The samples analysed in this study all contained heroin, however the concentrations present varied between low quantities (<1%) in two of the samples compared to a heroin content of over 30% in another sample. This fluctuation between heroin concentrations further suggests variability between suppliers. Due to relatively low quantities that were difficult to detect in the samples, several individual constituents could not be identified using nuclear magnetic resonance imaging (NMR). Noscapine and papaverine were however detected in samples. Research on the analysis of illicit heroin conducted by O'Neil and Pitts [1] as well as Baker and Gough [3], suggests that impurities contained in illicit heroin may provide a good indication of its origin. These articles however are not very recent and it is possible that the heroin manufacturing process has since become more efficient and the yield has improved with fewer impurities being found in the end product. The heroin manufacturing process by two Afghanistan nationals as documented by Zerell, Ahrens [4] shows that heroin content of the heroin hydrochloride they produced was 74 %, which was higher than heroin hydrochloride samples analysed by O'Neil and Pitts [1] that contained less than 70 % of heroin. The heroin hydrochloride samples analysed by O'Neil and Pitts [1] also show that noscapine and papaverine were either not present in the samples or represented less than 1.35 and 0.03 % of the sample respectively. There was no papaverine or noscapine present in samples analysed by Zerell, Ahrens [4] and this supports the theory that the illicit manufacturing process has become more efficient and contains fewer impurities.

The “Sugars” samples analysed in this study contained heroin, noscapine and papaverine as well as some compounds that were not identified as they were not detected by NMR analysis. Zerell, Ahrens [4] reports that noscapine and papaverine are removed as part of the purification of brown base heroin to white heroin base which ensures that the final heroin product does not contain papaverine or noscapine. Both noscapine and papaverine are opioid alkaloids and have anti-tussive and smooth muscle relaxing properties respectively [5]. Singh [6] states that “Sugars” is bulked “in order to increase volumes for wider distribution and bigger profits” and it therefore does not seem rational for suppliers to bulk “Sugars” with noscapine and papaverine as they cost approximately R1800 (100mg) and R430 (5g) respectively, making them fairly expensive ‘adulterants’. The results of this study therefore suggest that the heroin is not bulked up to form “Sugars”. In light of the literature presented and the results of the analysis conducted in this study, it is postulated that “Sugars” is a waste product of the heroin manufacturing process that is removed during the purification of brown heroin base, as described Zerell, Ahrens [4]. A possible discrepancy with this theory is the presence of heroin in “Sugars”, however, the heroin present in “Sugars” could possibly be heroin that was lost during the purification process and ended up as part of the waste product. The low content of heroin present in the “Sugars” samples analysed support this argument and the decreased heroin content between white heroin base and white heroin hydrochloride, which Zerell, Ahrens [4] attributes to filtration involved in purification process, further corroborates this theory. The loss of heroin via filtration can also possibly account for the variation of heroin content in “Sugars” as noted in this study.

The adulterants and impurities found in illicit heroin can provide an indication of the country the drug was sourced from. Previous countries associated with heroin trade include India, Pakistan, South East Asia, Turkey and Nigeria [1]. There is currently no contemporary literature available on this topic and therefore there is a lack of updated information that can be used to determine the origin of the heroin used in "Sugars".

3.2 Conclusion

The samples analysed in this study showed variation in colour and composition which indicates independence between sources. The variation of the samples suggests that the process of producing "Sugars" is an illicit and unregulated process and therefore the contents of the mixture is likely to vary. The findings of this study also indicate that "Whoonga" and "Sugars" are not the same composite as they do not have any common compound other than heroin and it is therefore unlikely that they are the same drug.

Over the years, the heroin manufacturing process has presumably improved and as such the quality of the final product may have improved and contains little or no impurities. As illustrated by Zerell, Ahrens [4], the waste product is removed during the final purification stages of the process and noscapine and papaverine are some of the impurities found in this waste. The final product in the above case did not contain noscapine or papaverine and it is therefore hypothesised that "Sugars" may be the waste product of the heroin manufacturing process. The low cost of the drug as well as the high variability of the contents of "Sugars" supports this argument and it therefore seems plausible that the drug is the waste product of the illicit heroin manufacturing process rather than the bulked up version of heroin, which would most likely have a similar composition between suppliers.

3.3 Limitations of the study

The limitations of this study was the inability to identify all compounds present in the crude samples analysed. This can be attributed to the highly variable nature of the drug which posed a challenge in narrowing down the possible ingredients of the cocktail. Further chemical analysis is therefore required with other available analytical methods and tools, and the identification of the unknown compounds present in the cocktail is part of an ongoing study.

3.4 Recommendations for future research

This study possesses potential to expand and future research can be conducted on South African street heroin to verify that "Sugars" is indeed the waste product of the manufacturing process of heroin. The results of this study suggest chemical variation of "Sugars" between sources, however it is necessary to analyse if variation occurs from a single source. This can be done by analysing samples over a given period of time in order to monitor the consistency of the contents present in "Sugars" from a single supplier. The

physiological effects of the cocktail and its constituents can be investigated in an animal model and biochemical assays and behavioural testing can provide an indication of whether the effects seen in addicts are due to a single ingredient or the combined effects of the ingredients.

REFERENCES

1. O'Neil PJ and Pitts JE. Illicitly Imported Heroin* Products (1984 to 1989): Some Physical and Chemical Features Indicative of Their Origin. *Journal of pharmacy and pharmacology*. 1992; 44: 1-6.

2. News H-e. Whoonga dealers are 'peddling poison'. *Witness*. South Africa2011.

3. Baker P and Gough T. The separation and quantitation of the narcotic components of illicit heroin using reversed-phase high performance liquid chromatography. *Journal of chromatographic science*. 1981; 19: 483-9.

4. Zerell U, Ahrens B and Gerz P. Documentation of a heroin manufacturing process in Afghanistan. *Bulletin on narcotics*. 2005; 57: 11-31.

5. Claus EP and Tyler VE. *Pharmacognosy*. Lea & Febiger, 1965.

6. Singh SB. " Ganja to Sugars": The History of substance abuse by Indian Youth in the working class township of Chatsworth, Durban. *The Oriental Anthropologist*. 2012; 12: 349.

APPENDIX A

health
Department:
Health
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF HEALTH
Private Bag X828
PRETORIA, 0001
Republic of South Africa

UMNYANGO WEZEMPILO
LEFAPHA LA MAPHELO

PERMIT IN TERMS OF SECTION 22A(9)(a)(i) OF THE MEDICINES AND RELATED SUBSTANCES ACT, 1965 TO ACQUIRE, POSSESS AND USE SCHEDULE 6 AND 7 SUBSTANCES FOR ANALYTICAL TESTING PURPOSE.

Date of Issue: 02 September 2016	Expiry Date: 03 September 2016	Permit No: POS 290/2015/2016

Authority is hereby granted in terms of Section 22A(9)(a)(i) of the above-mentioned Act to **Ms Y Y Chetty** of **University of KwaZulu-Natal, Collage of Health Sciences, Westville Campus, Durban** to acquire, possess and use, subject to the conditions stated, the under-mentioned Schedule 6 and Schedule 7 substances in respect of which the quoted quantity should not be exceeded during the period **02 September 2016** to **03 September 2016.**

Name of Scheduled Substance(s)	Schedule	Total quantity of substance(s) and/or preparation(s) allocated per calendar year
Heroin	S7	30g [thirty gram]
Cocaine	S6	30g [thirty gram]

Total Items: **2**

The acquisition, possess and use the relevant substances are subject to the following conditions:

1. The substances shall be used for **research purposes** only.
2. The control over the substances shall be the responsibility of:

   Full Name & Surname: **Ms Y Y Chetty**

   ID Number: **920131 0142 083**
3. Complete details of the substances acquired and used shall be recorded in registers designed specifically for this purpose in accordance with the provisions of the relevant regulations to the Medicines and Related Substance Act, 1965.
4. Orders for the substances shall be signed for by:
5. **Full Name & Surname:** **Ms Y Y Chetty**

   ID Number: **920131 0142 083**
6. When the substances are acquired, the name and address of the supplier, the date supplied, the quantity supplied and the number of the relevant invoice shall be recorded **on this permit**.
7. The register referred to in paragraph 3, as well as copies of orders and invoices pertaining to the supply of the substances, shall be available at the offices of the **University of KwaZulu-Natal, Collage of Health Sciences, Westville Campus, Durban** for a period of at least three years and shall be subject to inspection by Inspectors appointed in terms of the Medicines and Related Substances Act, 1965.
8. This permit expires on **03 September 2016** and shall on expiry be returned to the Department of Health for cancellation and shall be accompanied by a statement reflecting the quantity of substances on stock at expiry.

[redacted]

DIRECTOR-GENERAL:
DEPARTMENT OF HEALTH

DATE: 02/09/2015