

The poppy seed defense: scientifically sound?

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Introduction

Since the infamous Seinfeld episode, there has been much doubt cast upon the relationship between the effects of poppy seed ingestion and testing positive for opiates. In the episode, Elaine fails a drug test after eating a poppy seed bagel for breakfast. A number of quasi-scientific sources, such as the TV show *MythBusters*, and several published scientific articles have since confirmed the effect of poppy seed consumption on positive drug testing. However, the amount of poppy seeds necessary for a positive result remains unknown. Additionally, the range of concentrations of morphine and codeine in poppy seeds makes it hard to determine a legitimate threshold value for the concentration of morphine in order to test positive, as there is currently no method that is able to conclusively distinguish poppy seed enthusiasts from drug users based on urine samples.

Testing subjects

Detection of opiates in urine, concentration of morphine and codeine in poppy seeds, and effects of excess poppy seed consumption

Scientists rarely use blood samples when testing for morphine and codeine concentrations, as urine samples are both quicker and more practical (Moeller, Manfred, Hammer, and Engle, 2004). Usually, both morphine and codeine are present in urine and blood after either injecting opiates such as heroin or smoking opium. In tests conducted by C. Meadway, George, and Braithwaite in 1998, participants who consumed large amounts of poppy seeds from either one or two poppy seed rolls had high concentrations of normorphine, morphine, thebaine, norcodeine, and codeine in their urine sample. Notably, the concentration of norcodeine in the participants' urine was exceptionally high, at almost twice the concentration of morphine.

In their study, the concentrations of morphine and codeine peaked in all participants at around the two-hour mark, and, using a cutoff concentration of 300 ng/mL, all participants tested positive for opiates two hours after consumption. However, another study found that participants still tested negative one hour after consumption of a very large amount of poppy seeds, equivalent to those in one fifth of a poppy seed cake, although a number of subjects continued to test positive for up to twenty-four hours post-ingestion (Pettitt, Dyszel and Hood in 1987). This suggests it takes the body some time to process the poppy seeds in the digestive tract. While Hayes, Krasselt and Mueggler (1987) found that their subjects tested negative after 48 hours, Bonicamp and Santana (1998) found that both of their participants still tested positive after the same time period. These time lapse differences can be partially accounted for by the amount of poppy seeds ingested, the participants' body mass index variability, and laboratory techniques used that could impact the concentration of opiates detected in the urine and blood samples.

The concentration of morphine and codeine in different strands of the seeds is also variable. For black poppy seeds, gas chromatography was used to find that the morphine concentration was 17-294 $\mu\text{g/g}$, and the codeine concentration was 3-14 $\mu\text{g/g}$, depending on the source and variety of the poppy seeds (L.W. Hayes, Krasselt and Mueggler 1987).

Moeller, Manfred, Hammer, and Engle (2004) compared the seeds' morphine content by country of origin. Seeds available through a retail store in Oregon had the highest morphine content at 294 mg/kg. Comparable values were found for seeds from Spain (at 251 mg/kg) and Australia (at 200 mg/kg). In this study, samples from Turkey had the lowest content, with some samples containing less than 0.5 mg/kg of morphine. Since the range of concentrations of morphine reported here was based on testing several more varieties of poppy seeds than in other experiments, it is reasonable to suggest that their values are close to the actual range of opiate concentrations.

The effects of ingesting a large amount of poppy seeds on physical and psychological health are unknown. In at least one documented case, a patient with a prescription for methadone had an increased concentration of methadone in his urine upon consumption of poppy seeds (Narcessian and Jung Yoon 1997). These results imply that a high dose of poppy seeds could have negative physiological effects for medicated subjects. In another experiment, communicative and interactive tests (such as walking a straight line or reciting a sentence) were used to determine if participants seemed to be under the influence of opiates after consuming poppy seeds; neither a police officer nor a physician found any evidence suggesting drug usage (Moeller, Manfred, Hammer, and Engle, 2004). However, the same experiment reported that the individual who consumed the largest quantity of poppy seed cake in relation to their body weight "reported a light drug effect including drowsiness with reduced pupil reaction time."

Cutoff rates and by-products identifiable in a subject's urine

Determining whether a subject is a poppy seed enthusiast or a drug user

Many of the above experiments used a threshold concentration of 300 ng/mL, defining higher concentrations as positive tests. However, the United States has recently changed its threshold value to 4000 ng/mL for morphine and 2000 ng/mL for codeine in acknowledgement of the poppy seed defense (Meadway, George, and Braithwaite, 1998). The International Olympic Committee (IOC) has set their threshold for morphine at 1000 ng/mL, and has agreed to re-examine any disputed case upon request (Yonamine, Rodrigues Garcia, and de Moraes Moreau, 2004). Others argue that changing the original threshold value is unnecessary, as a very large quantity of poppy seeds, more than what might be contained in a bagel, would need to be consumed to have a urinary morphine concentration greater than 300 ng/mL. Conversely, Meadway, George, and Braithwaite (1998) found that the maximum concentration of morphine in urine samples after ingesting only 4.69 g of poppy seeds, about one slice of poppy seed cake, was 302 ng/mL. Because of these controversies, scientists have searched for a chemical by-product of either an opiate drug or poppy seeds that would help to distinguish them. Initially, thebaine, a component of poppy seeds, was suggested as a differentiating compound, but was soon discarded because of high between-individual variability in the concentration of thebaine (Moeller, Manfred, Hammer, and Engle, 2004). In an experiment by Meadway, George, and

Braithwaite (1998), only half of the participants tested positive for thebaine after a small dose of poppy seeds while all tested positive after a larger dose. A further complication arises in that if thebaine was used as an indicator, a participant could potentially mask their opiate use by consuming poppy seeds prior to testing, to be subsequently vindicated by the presence of thebaine. In 1998, two scientists from New York proposed the presence of 6-Monoacetylmorphine (6-MAM) to differentiate between an opiate drug user and a poppy seed eater, claiming that 6-MAM was not detected in their participants' urine samples after they had eaten poppy seed bagels (Mulé and Casella, 1998). Although Meadway, George, and Braithwaite (1998) agreed with these findings, they are quick to point out limitations; for example, 6-MAM is present in relatively low concentrations, so the method of detection must be very sensitive. Additionally, they found its half-life to be of only 30 minutes, indicating that the sample would need to be tested promptly after drug use to test positive for 6-MAM. In spite of these results, members of the U.S. Department of Defense and the Department of Health and Human Services, Buddha, Shimomura, and Smith (1999), set out to determine appropriate cutoff values for morphine, codeine, and 6-MAM required to confirm heroin usage. It found that 1113 samples out of 422 237 were positive for opiates, but of those, only 17 showed a detectable amount of 6-MAM. Among the participants who did not test positive for 6-MAM, it was never stated how many were heroin users, and how many were simply heavy poppy seed eaters, making the results of this study of limited practical significance.

Conclusion

It is currently impossible to accurately determine the cause of a positive urinary test for opiates. Because the amount of poppy seeds ingested, the concentration of morphine and codeine in different varieties of poppy seeds, the subject's body mass index, and laboratory techniques used can all vary, it is recommended to follow the IOC's example and examine each case individually to determine the nature of a positive test for opiates. Until a valid and reliable differentiator is identified, however, the poppy seed defense will continue to be used. Even though the international community has begun to accept poppy seed consumption as a legitimate defense for a positive opiate test, it is recommended to avoid poppy seeds

for up to 48 hours before a scheduled drug examination.

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