Examining the Effects of Cannabis-based Edibles on Cognitive Health and Simulated Driving Performance in Young Adult Drivers

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Executive Summary

Background

Following the legalization of cannabis in Canada in 2018, its use among young adults (ages 19-30) has significantly increased, with recent data indicating 32% of individuals aged 20-24 and 27% of those aged 16-19 consume cannabis. This trend raises significant road safety concerns, as tetrahydrocannabinol (THC), the primary psychoactive compound in cannabis, is known to impair cognitive and motor functions essential for safe driving. These concerns coincide with the fact that young drivers aged 18 to 25 years are considered a high-risk group that engage in risky driving behaviours (e.g., distracted driving; speeding) that contribute to them having the highest crash rates compared to all other age groups in Canada.

Studies show that cannabis can impair decision making, reaction time, concentration, memory, divided attention, and visual function. These impairments can translate into difficulties maintaining lane positioning, an appropriate following distance, speed regulation, reduced rule following, navigating complex traffic situations and unexpected events (e.g., pedestrians crossing the road). More importantly, prior data shows discrepancies between perceived and actual ability for adults while driving under the influence of cannabis. For example, studies report that some young adults do not perceive cannabis to significantly impair their driving, which may be due to the lack of policies and evidence surrounding the effects of cannabis on driving performance.

While studies show evidence that cannabis can impair driving performance, there is a paucity of research on whether specific cannabis types have differential effects on driving performance. Cannabis consumption via smoking and vaping impairs driving performance, however, there have been no studies that have examined the effects of edibles on driving performance. Edibles have become the most popular method of cannabis consumption, with 53% of those who reported using cannabis, do so by consuming

edibles. The two most common cannabis types are sativa and indica and both have different side effects. Sativa is associated with energetic effects while indica is associated with calmness and relaxation. It is hypothesized that sativa will lead to over-speeding and poorer vehicular control while indica will result in poorer decision making and slower reaction time.

The present project aimed to investigate the effects of cannabis-based edibles on cognition and simulated driving performance in young adult drivers between the ages of 19 and 30. This project consisted of two inter-related objectives: (1) to determine when cognition and driving is most compromised, and for how long they are compromised after edible consumption and (2) to examine the associations between participants' perceived and actual simulated driving performance and whether their perceptions change post-edible consumption.

Methods

This study was approved by Health Canada and the Behavioural Research Ethics Board at the University of Saskatchewan [REB #3289], which involved young adult drivers (aged 19-30 years) attending a single in-person session which lasted approximately 8 hours. Data collection took place from February 2025 to July 2025 in the Driving Research and Simulation Laboratory at the University of Saskatchewan.

Participants were recruited through social media (e.g., Facebook; Reddit; X) and interested participants contacted the research team via email or office phone to undergo screening and enrollment. Young adult drivers were eligible to participate if they: (1) were a permanent resident of Canada or a Canadian citizen, (2) between 19-30 years of age, (3) resided in Saskatoon, Saskatchewan, (4) had no current or past history of substance abuse, (5) consumed cannabis (in any form) once per week or less, (6) consumed 10 mg or less of THC per session, (7) possessed a valid Class 5 drivers' license, (8) were not pregnant or breastfeeding and used contraception if female (pregnancy status was confirmed by a urine

pregnancy test on the date of study session), (9) had no sensory or motor deficits in upper or lower limbs, (10) had no current or past health conditions (e.g., seizures; kidney or renal disease; Amyotrophic Lateral Sclerosis; cardiovascular disease), (11) had no family history of schizophrenia, psychosis, or cancers, (12) were only taking approved prescription medications outlined by Health Canada, (13) were proficient in written and spoken English, and (14) were at no/low risk for Simulator Adaptation Syndrome (SAS).

- In total, 458 participants were screened for eligibility:
    - Of those, 293 participants did not meet the inclusion criteria.
    - The remaining 165 young drivers met the eligibility criteria for this study.

From this group of eligible individuals (n=165), all participants were assigned a unique ID number, which was placed in a random number generator and randomly selected. Selected participants were subsequently scheduled for their study session.

- In total, 65 young adult drivers participated in the study:
    - Fifty participants completed all aspects of the study.
    - Eleven participants were withdrawn from the study due to developing SAS and four participants were withdrawn due to failing the urine test.

A taxi was provided to and from the participants' home to the DRSL on the date of their session. Once participants arrived for their session, informed consent was obtained, urine drug (four participants failed) and pregnancy tests (no participants failed) were administered, followed by a questionnaire gathering information on their demographics. Driver perception (e.g., Driving Comfort Scales Day (DCS-D) and Night (DCS-N); Perceived Driving Abilities (PDA)), cognitive (e.g., Trail Making Test A (TMTA) and B (TMTB); Useful Field of View (UFOV); Digit Span Forward and Backward) and visual (e.g., depth perception) assessments, as well as simulated drives were completed prior and after edible

consumption (i.e., 1.5; 2.5; 4; and 6 hours). All participants consumed 10mg of THC in edible form.

Participants then drove on the Virage VS500M car simulator, first completing an acclimation drive (approximately 20 minutes), followed by three driving scenarios (approximately 40 minutes). On the first scenario, reaction time (seconds) and the number of adjustment to stimuli errors and collisions were reported when participants had to respond to a pedestrian suddenly entering the roadway. The second scenario measured reaction time in four different speed zones (i.e., 50km/hr, 70km/hr, 90km/hr, and 110km/hr) by instructing the participant to brake abruptly upon hearing the sound of a bell. The third scenario began with driving in a rural highway and then driving into the city. Metrics, including average, minimum, and maximum speed; average, minimum, and maximum headway time while merging and in traffic, respectively; and the number of collisions with animal, pedestrian, and roadway hazards were captured. These variables corresponded to driving errors such as speed regulation, lane maintenance, vehicle position, adjustment to stimuli, and collisions. The three simulated driving scenarios were selected to reflect driving conditions and errors that are exhibited in real-world conditions and events experienced by young adult drivers. While the same three simulated scenarios were used to test driving performance at each timepoint, slight variations were made to limit memorization of the scenario.

Results

The average age of participants was 23.8 years, ranging from 19-30; 50% were female and 50% were male. Over half the sample were Caucasian (60.0%), had at least some university or college education (46.0%) and had 5 years of driving experience (86.0%). Approximately one fifth of the sample had received a citation in the past year. Of those who received a citation, the most common reason was speeding (66.7%), followed by failure to stop at a stop

sign (11.1%), tailgating (11.1%), and not driving with a valid permit (11.1%). Only 14% were involved in crash in the past year; 42.9% of them were at-fault.

For objective one, scores on the TMTA ($p<0.001$), TMTB ($p<0.001$), Digit Span Forward ($p<0.001$), Digit Span Backward ($p=0.019$), and UFOV-2 ($p=0.021$) were significantly different across all timepoints post-edible consumption. On the TMTA and TMTB, post-hoc analyses revealed participants' scores were significantly worse (i.e., slower time to completion) at 1.5 hours compared to 4 and 6 hours, respectively, post-edible consumption. Additionally, participant TMTA and TMTB scores at 2.5 hours were significantly worse compared to 6 hours post-edible consumption. Similarly, participant TMTB scores, but not TMTA scores, were significantly worse at 4 hours compared to 6 hours post-edible consumption ($p<0.001$). On the Forward Digit Span, post-hoc analyses revealed participants' scores were significantly worse (i.e., cannot recall longer sequences of numbers) at 1.5 hours compared to participants scores at 4 ($p=0.039$) and 6 hours ($p=0.002$) post-edible consumption. Moreover, scores on the Forward Digit Span were significantly worse at 2.5 hours compared to 6 hours ($p=0.002$) but no differences were found between 4 and 6 hours. On the Backward Digit Span, post-hoc analyses revealed participants' scores were significantly worse (i.e., cannot recall longer sequences of numbers) at 1.5 hours ($p<0.001$) and 4 hours ($p=0.031$) compared to participants scores at 6 hours post-edible consumption. Lastly, post-hoc analyses revealed participants UFOV-2 scores were significantly worse (i.e., slower time to completion) at 1.5 hours compared to participants scores at 4 ($p=0.009$) and 6 hours ($p=0.028$) post-edible consumption. There were no significant differences across time points on depth perception, UFOV-1 or UFOV-3 scores, or the UFOV-RI.

The sample's driving performance significantly varied across all timepoints (i.e., 1.5, 2.5, 4, and 6 hours after edible consumption). During the first simulated drive (combining

trials 1 and 2), participants' average reaction time was slowest at 1.5 hours compared to 4 ($p=0.046$) and 6 hours ($p=0.005$) post-edible consumption. Additionally, post-hoc analyses revealed participants' average response time (reaction + movement time) was significantly slower at 1.5 hours compared to 2.5 hours ($p=0.001$), 4 hours ($p=0.001$) and 6 hours ($p<0.001$) post-edible consumption. Moreover, participants made significantly more speed regulation errors at 1.5 hours compared to 4 ($p=0.033$) and 6 hours ($p=0.021$) post-edible consumption.

During the second simulated drive, participants' average reaction time (averaged across all four trials) was significantly slower at 1.5 hours compared to 2.5 hours ($p=0.016$), 4 hours ($p<0.001$), and 6 hours ($p<0.001$) post-edible consumption.

On the third simulated drive, participants made more lane maintenance errors at 1.5 hours compared to 6 hours post-edible consumption ($p=0.026$), while lane maintenance errors at all other timepoints were not significantly different from 1.5 hours post-edible consumption. Additionally, participants made significantly more speed regulation (over-speeding) errors at 4 hours ($p=0.020$) and 6 hours ($p=0.002$) compared to 1.5 hours post-edible consumption. Lastly, participants were involved in significantly more collisions with roadways and other vehicles at 4 hours ($p=0.018$), and significantly fewer at 6 hours ($p=0.008$), compared to 1.5 hours post-edible consumption. At 1.5 hours post-edible consumption, 30% of participants crashed compared to 44% at 2.5 hours, 58% at 4 hours, and 16.0% at 6 hours.

When examining the perceptions of participants (objective 2), DCS-D scores were significantly worse at 1.5 hours compared to 2.5 hours ($p=0.004$), 4 hours ($p<0.001$), and 6 hours ($p<0.001$) post-edible consumption. Similarly, participants' DCS-N scores were significantly worse (i.e., lower scores indicate worse comfort driving at night) at 1.5 hours compared to 2.5 hours ($p<0.001$), 4 hours ($p<0.001$), and 6 hours ($p<0.001$) post-edible

consumption. Additionally, PDA scores were significantly worse (i.e., lower score indicate worse perceived driving abilities) at 1.5 hours compared to 2.5 hours ($p=0.006$), 4 hours ($p<0.001$), and 6 hours ($p<0.001$) post-edible consumption. Participants were additionally asked whether they felt safe to drive (i.e., Yes/No) at each timepoint (i.e., baseline; 1.5 hours; 2.5 hours; 4 hours; 6 hours) prior to undergoing the simulated driving tests. Prior to consuming edibles, all participants felt safe to drive (100.0%), however, only 4% felt safe at 1.5 hours, 6% at 2.5 hours, 18% at 4 hours and 36% at 6 hours.

Discussion and Recommendations

Our findings showed that participants performed significantly worse on the cognitive tests immediately after edible consumption. For example, tests that examine visual search (TMTA), divided attention (UFOV-2) and set-shifting (TMTB), working memory and attention (Digit Span tests) were all significantly worse at 1.5 compared to other time points. Additionally, participants performed significantly worse on the TMTA, TMTB, and Digit Span tests at 2.5 hours compared to 4 and 6 hours, respectively, after edible consumption. Over time, participants' cognitive abilities improved, almost back to normal at 6 hours post-edible consumption. This indicates that participants cognitive abilities are poorer immediately after cannabis consumption, and while cognitive abilities do get better over time (even at 6 hours), there are still effects of cannabis that linger for hours after consumption. This is confirmed by the fact that participants were significantly involved in more collisions even at 4 hours post cannabis consumption compared to 1.5 hours. Even at 6 hours after consuming cannabis, 16% of the sample still crashed although it was significantly less compared to 1.5 hours. However, it is also important to note that a high proportion of participants crashed at all points of time post-edible consumption. For example, 30% crashed immediately after cannabis consumption (1.5 hours), 44% at 2.5 hours and 58% at 4 hours post consumption. When examining specific driving metrics, participants made significantly more lane

maintenance errors at 1.5 hours compared to 6 hours, and significantly more speed regulation errors (speeding) at 4 and 6 hours compared to 1.5 hours. Additionally, participants had poorer reaction time at 1.5 hours compared to other time points. This further indicates that various driving skills/tasks are compromised after edible consumption that may contribute to crashes (e.g. poorer reaction time, over-speeding, not staying in the lane).

We observed that participant perceptions (DCS-D, DCS-N and PDA scores) were the lowest at 1.5 hours indicating they were less comfortable and felt their driving abilities were impacted by the edibles. Participants DCS-D, DCS-N, and PDA scores gradually increased throughout the session, nearly returning to their scores prior to cannabis consumption. These scores align with the participants' perception that they were not safe to drive while under the effects of cannabis. For example, only 4% felt safe at 1.5 hours, 6% at 2.5 hours, 18% at 4 hours and 36% at 6 hours, indicating that participants still felt their driving abilities were being impacted by cannabis through the session.

There are a few considerations to keep in mind when interpreting the study findings. While we didn't report the baseline scores of the cognitive tests, participants scored similarly on baseline and at 1.5 hours post-cannabis consumption. This means that the effects of cannabis likely could have lingered longer than we could detect because of the learned effects of completing the cognitive tests and simulated drives.

Conclusions

This study highlights that the consumption of 10mg THC via edibles in recreational young adult users impairs cognition and driving performance, even up to 6 hours post consumption. While research indicates the effects of edibles take longer to manifest compared to smoking or vaping, the effects are apparent at 1.5 hours and linger up to 6 hours, and likely beyond. Drivers who consume edibles should plan for alternative arrangements to get home (if out) given driving performance can be impacted by the effects of THC.