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Research Paper

IMPACT OF ELECTRON BEAM IRRADIATION ON CANNABIS QUALITY OVER TIME

A Chemical and Sensory Evaluation

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7th August, 2025

Abstract

Electron beam (e-beam) irradiation is an increasingly common method for decontaminating cannabis, particularly in European and Canadian markets. While its effectiveness in microbial load reduction is well established, there remains limited understanding of its long-term impact on overall cannabis quality. This blinded, randomized, controlled study investigates the chemical and sensory evolution of irradiated and non-irradiated cannabis over a 6-month period, evaluating changes in total THC, trichome condition, aroma, joint performance, and undesirables.

The irradiated sample experienced a 9.67% decline in total THC compared to a 0.79% decline in the non-irradiated control. Grading results revealed microseed formation, shifts in trichome coloration, and lower curing scores in irradiated samples over time. Findings suggest that irradiation may temporarily elevate surface THC readings while accelerating resin gland degradation, highlighting the importance of integrating lab testing with structured sensory evaluation assessment.

Background

Irradiation is widely used across global food and pharmaceutical industries to improve microbial safety. In the cannabis sector, e-beam irradiation is increasingly deployed to ensure compliance with microbial standards, especially for medical exports [1]. However, it is not commonly disclosed to consumers whether a product has been irradiated. While Bedrocan has reported that gamma irradiation does not substantially affect total THC content, the same study observed notable degradation of terpenes post-irradiation [2] and did not include any follow-up analysis. Since terpenes are critical to aroma, flavor, and potentially entourage effects, this loss could meaningfully alter perceived quality. Furthermore, most studies focus narrowly on potency and microbial reduction, omitting qualitative aspects such as aroma evolution, trichome condition, or physical defects like microseed formation. This study aims to fill that gap by combining high-performance liquid chromatography (HPLC) potency testing with structured organoleptic assessment via the Sensemillier Grading Platform. We propose a mixed-methods approach as a blueprint for future quality research in the cannabis field.

Method

Study Design

This was a blinded, randomized controlled study comparing irradiated and non-irradiated samples from a single cultivar. Evaluations were conducted immediately post-treatment and again after 6 months.

Sample Collection and Preparation

A batch of homogenized cannabis flower from a Canadian licensed producer was split into two subsamples. Each was assigned a code and one was sent for irradiation (10 kGy, e-beam). The identity of the irradiated sample was retained by the producer and not disclosed until unblinding. Samples were stored in identical, UV-resistant packaging under controlled conditions. Subsamples were randomized for testing and grading.

Microbial Analysis

All samples underwent microbial testing in accordance with European Pharmacopeia 5.1.8 guidelines [3]. Results showed no detectable contamination.

Cannabinoid Testing

Cannabinoid profiles were analyzed via HPLC. Total THC was calculated using the formula: Total THC = THCA x 0.877 + Delta-9-THC [4].

Sensory Evaluation

Blind grading was conducted using the Sensemillier Grading Platform. Three panelists evaluated visual appeal, trichome development (outer/inner), aroma intensity and complexity, joint flavour, and smoothness. Microscopy was used to observe trichome morphology and presence of undesirables such as seeds or contamination.

Results

Cannabinoid Stability

Sample	Day 0 Total THC (%)	Month 6 Total THC (%)	% Change
XY1023 (Control)	22.76	22.58	-0.79%
ZT2045 (Irradiated)	25.66	23.18	-9.67%

ZT2045 exhibited higher initial THC, possibly due to post-irradiation surface conversion. However, it showed a more significant decline over time.

Microbial Results

All microbial thresholds were met at both timepoints. There was no reemergence of contamination after 6 months.

Grading Results (Summary)

- **Curing score**s declined in both samples over time, though XY1023 consistently maintained higher values at each testing point.
- **Trichome Inner Colour** in both samples faded over time, but ZT2045 remained darker overall.
- **Final Bud Score** dropped more significantly in XY1023 (from 3.76 to 3.12).
- **Joint Performance** improved for both samples, with ZT2045 matching XY1023 at 6 months (both 3.75).
- **Aroma Scores** remained high for ZT2045 (4.83 to 4.75), declining in XY1023.
- **Undesirables**: Microseeds were discovered in ZT2045 at 6 months; none were found in XY1023.

Grading Results

Final Score		
	XY1023	*ZT2045*
Month 1	3.63	3.19
Month 6	3.44	3.56

Final Bud Score		
	XY1023	*ZT2045*
Month 1	3.76	3.5
Month 6	3.12	3.36

Final Joint Score		
	XY1023	ZT2045
Month 1	3.5	2.88
Month 6	3.75	3.75

Aroma		
	XY1023	*ZT2045*
Month 1	4.66	4.83
Month 6	3.75	4.75

Curing Score		
	XY1023	ZT2045
Month 1	3.76	2
Month 6	1.5	1

Final Trichome Score		
	XY1023	ZT2045
Month 1	3.06	2.73
Month 6	3.2	3.2

Trichome Inner Colour		
	XY1023	ZT2045
Month 1	2.66	1
Month 6	1	1

Trichome Outer Colour		
	XY1023	ZT2045
Month 1	2.33	2
Month 6	4.5	5

Trichome Inner Development		
	XY1023	ZT2045
Month 1	3.66	3.66
Month 6	3.5	3.5

Trichome Outer Development		
	XY1023	ZT2045
Month 1	3.66	4
Month 6	3	3.5

Smoothness		
	XY1023	ZT2045
Month 1	3	3
Month 6	5	4

Drypull		
	XY1023	ZT2045
Month 1	5	3.5
Month 6	4	4.5

Flavour		
	XY1023	ZT2045
Month 1	4	3
Month 6	3	3.5

Undesirables		
	XY1023	ZT2045
Month 1	N/A	N/A
Month 6	N/A	Microseeds

Lab Results

Sample	Duration	Analyte	LOQ (%)	Result (%wt/wt)	Result (mg/g)
XY102300125	0 Days	Tetrahydrocannabinolic acid (THCA)	0.1	23.96	239.6
XY102300125	0 Days	Delta-9-tetrahydrocannabinol (D9-THC)	0.1	1.74	17.4
XY102300125	0 Days	Total THC	0.1	22.76	227.6
ZT204500425	0 Days	Tetrahydrocannabinolic acid (THCA)	0.1	27.41	274.1
ZT204500425	0 Days	Delta-9-tetrahydrocannabinol (D9-THC)	0.1	1.63	16.3
ZT204500425	0 Days	Total THC	0.1	25.66	256.6
XY102300325	6 months	Tetrahydrocannabinolic acid (THCA)	0.1	23.56	235.6
XY102300325	6 months	Delta-9-tetrahydrocannabinol (D9-THC)	0.1	1.92	19.2
XY102300325	6 months	Total THC	0.1	22.58	225.8
ZT204500125	6 months	Tetrahydrocannabinolic acid (THCA)	0.1	24.3	243
ZT204500125	6 months	Delta-9-tetrahydrocannabinol (D9-THC)	0.1	1.87	18.7
ZT204500125	6 months	Total THC	0.1	23.18	231.8

Discussion

Degradation Trends

Total THC degradation was significantly greater in the irradiated sample. While e-beam irradiation initially boosted surface THC expression, this was followed by accelerated THCA loss, suggesting oxidation or breakdown pathways were stimulated. Trichome browning and shrinkage were also more evident in ZT2045. Although THC is often used as the primary quality indicator in retail and medical markets, this temporary inflation may give a misleading impression of potency. Our findings underscore the need for more representative metrics of quality.

Inflated Potency and Misleading Metrics

The artificial elevation of THC readings immediately post-irradiation is especially problematic in markets where THC percentage remains the dominant quality metric. Consumers and purchasers may unknowingly prefer irradiated batches that appear more potent at first glance—only to experience rapid degradation shortly thereafter. This illusion of enhanced strength could distort patient outcomes, recreational expectations, and pricing structures alike.

Microseeds and Structural Instability

Microseed formation in the irradiated sample raises questions about irradiation-induced stress responses in floral tissue. While not widely documented, this aligns with similar post-irradiation tissue instability observed in other botanicals [5].

Methodological Innovation

This study showcases the value of combining chemical and sensory data. Use of the Sensemillier Grading Platform enabled detection of subtle shifts in aroma, trichome tone, and consumption experience that would not appear in lab assays alone.

Limitations

- Only one cultivar was tested.
- Joint evaluations at 60 days were conducted by a single grader.
- Terpene degradation and moisture loss were not quantified.

Future Research

Future research suggestions will focus on exploring other irradiation methods and evaluating their long-term impact on cannabis quality over extended storage periods. Building on this study's methodology, future work should prioritize using both laboratory testing and structured sensory evaluation in tandem to generate richer, more holistic datasets.
Key directions include:

- Comparison of irradiation types (e.g., gamma, e-beam, X-ray) across multiple dose levels to assess differential effects on cannabinoid stability, terpene retention, and structural integrity.
- Investigating the persistence of microbial sterilization over time by tracking intentionally contaminated samples post-irradiation.
- Inclusion of multiple cultivars to evaluate whether certain genetic profiles are more resilient or more susceptible to irradiation-related degradation.
- Integration of terpene and moisture content analysis to quantify their role in perceived freshness and flavour profile retention.
- Expansion of the grading panel and repetition frequency to increase statistical power and sensory reliability.

This multidimensional approach could serve as a model for industry-wide quality assurance and transparency frameworks.

Conclusion

E-beam irradiation, while effective at sterilization, may compromise the long-term sensory and chemical stability of cannabis. By integrating chemical and organoleptic metrics, this study provides a blueprint for richer, more meaningful cannabis quality assessments. The presence of microseeds, trichome browning, and THC degradation support the need for post-irradiation best practices. Temporary inflation of THC values post-treatment further complicates consumer transparency and product integrity.

Acknowledgments

We would like to thank the following companies for their support in making this study possible:

- Local Cannabis Co.
- Coast Mountain Cannabis
- Northern Scientific Inc.

Thank you to these individual supporters for contributing to citizen science:

- Mike Misek
- Christopher Ribbeck
- Sherman Hom
- Paul Horvath
- Jodie Giesz-Ramsay
- Megan Malone
- David Hall
- Amin Hasham
- Barbara A Kiefer
- Max Montrose
- Anne Hall
- Alannah Davis
- David Thomes

About Sensemillier

Sensemillier is a thought-leading cannabis company ****dedicated to redefining how we evaluate and appreciate cannabis. Best known for the Sensemillier Grading Platform - a flagship digital guided sensory evaluation tool, supporting a richer, more evidence-based understanding of cannabis quality. Through research, education, and citizen science, Sensemillier is helping cultivate a more nuanced and transparent future for the plant.
Learn more at www.sensemillier.com.

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Appendix

Bud Appeal Pictures

XY1023 - Bud Appeal - 0 Months

XY1023 - 6 Months

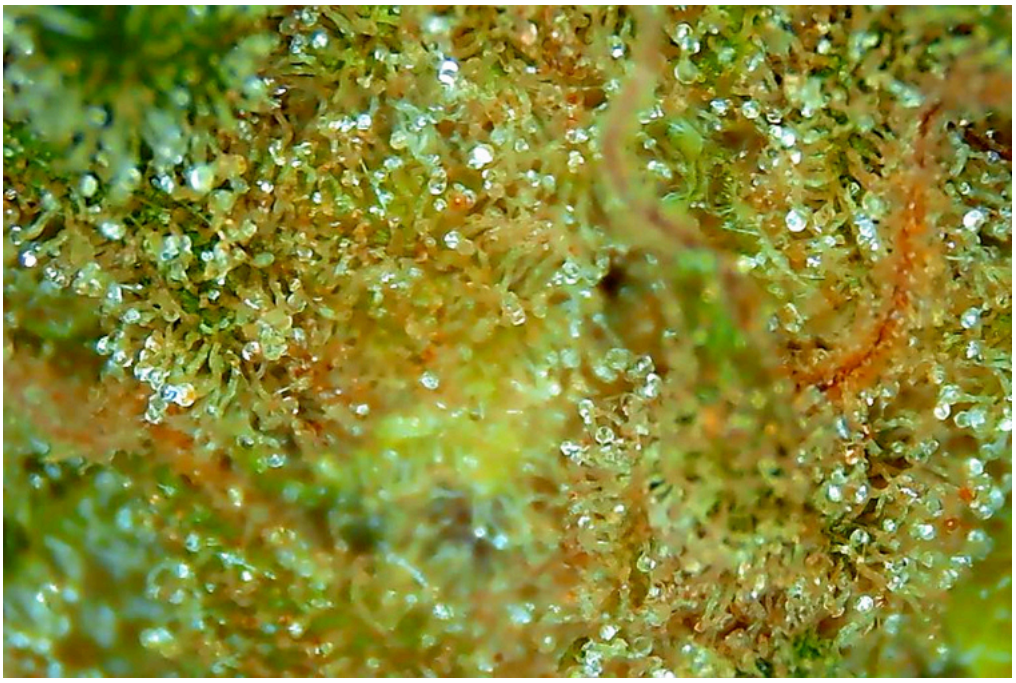
ZT2045 - Bud Appeal - 0 Months

ZT2045 - Bud Appeal - 6 Months

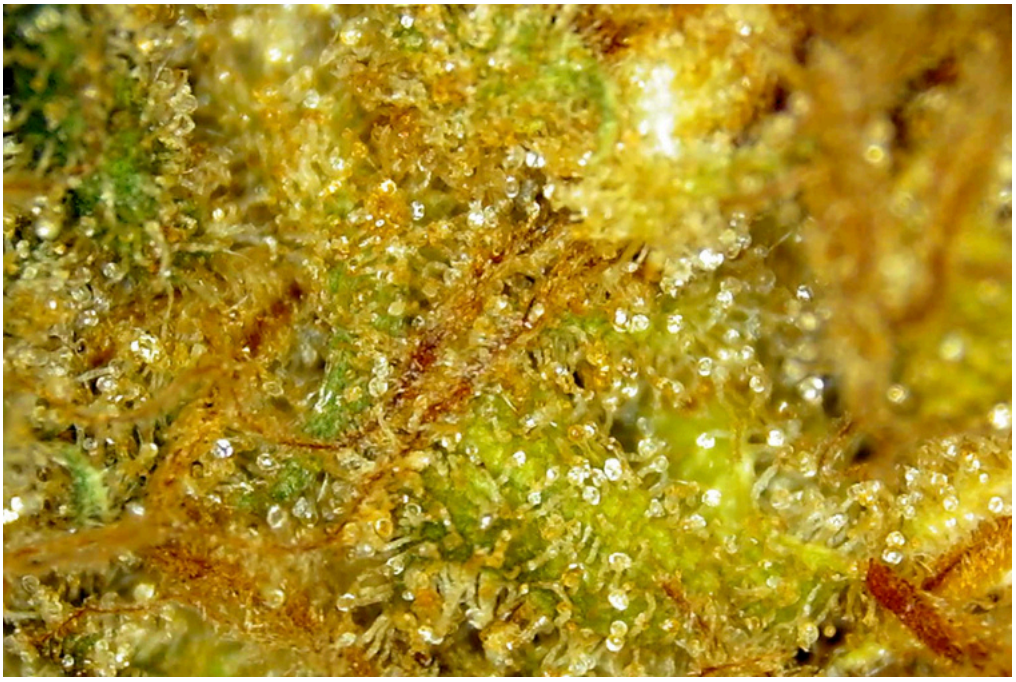
Microscopy Images

XY1023 - Trichome Head Colour and Robustness - 0 Months

XY1023 - Trichome Head Colour and Robustness - 0 Months



XY1023 - Trichome Head Colour and Robustness (Inner Surface) - 0 Months

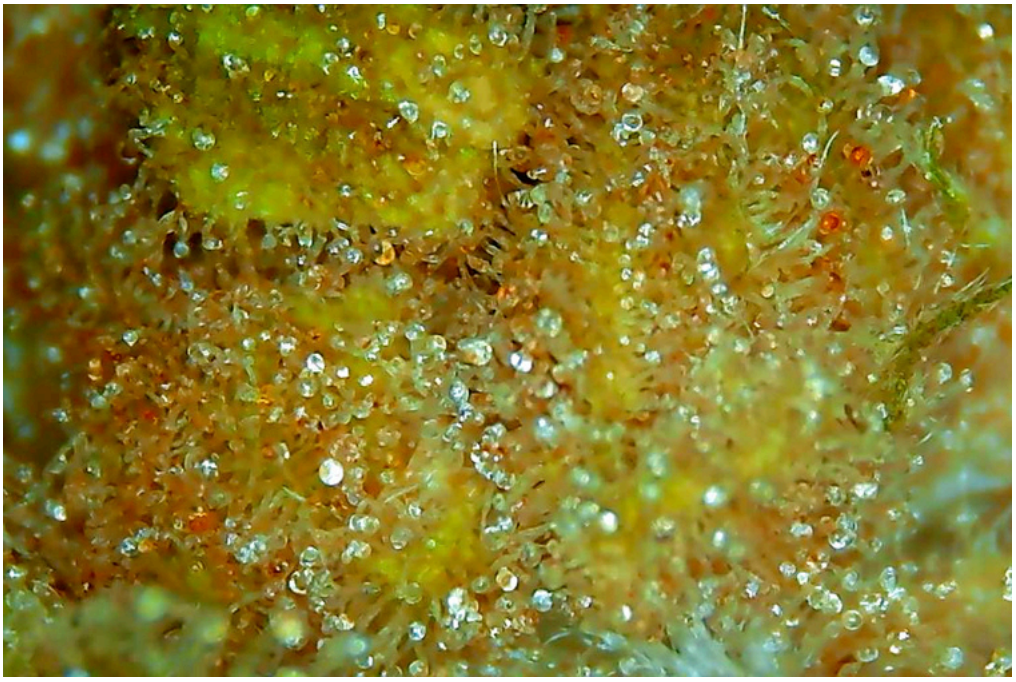


XY1023 - Trichome Head Colour and Robustness - 6 Months

XY1023 - Trichome Head Colour and Robustness - 6 Months

XY1023 - Trichome Head Colour and Robustness - 6 Months

ZT2045 - Trichome Head Colour and Robustness (Outer Surface) - 0 Months



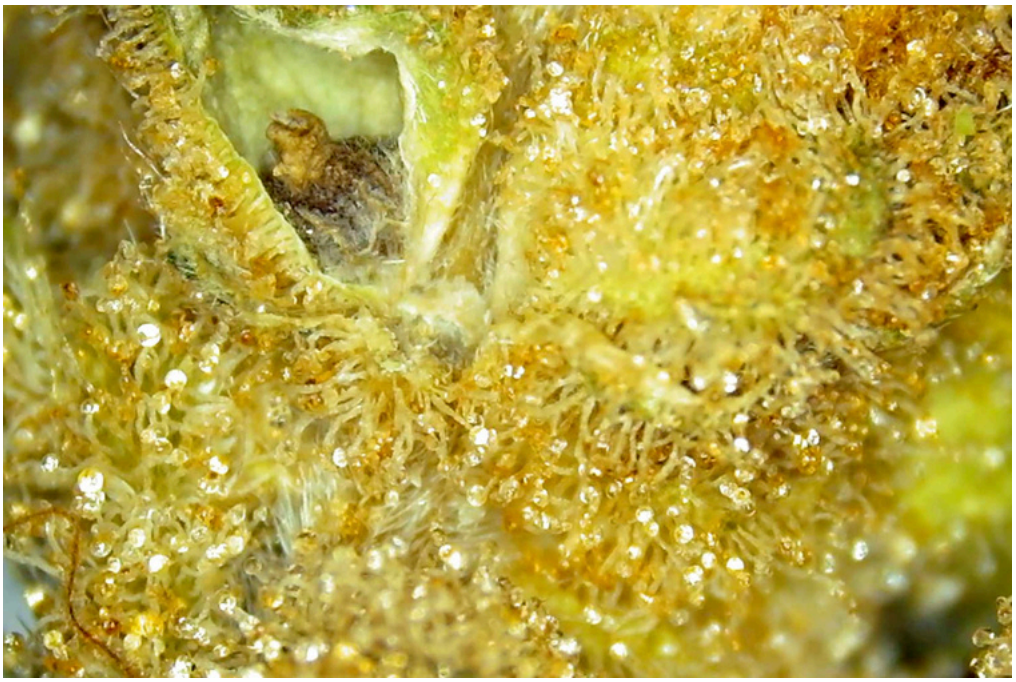
ZT2045 - Trichome Head Colour and Robustness - 0 Months

ZT2045 - Trichome Head Colour and Robustness (Inner Surface) - 0 Months

ZT2045 - Trichome Head Colour and Robustness - 6 Months

ZT2045 - Trichome Head Colour and Robustness - 6 Months

ZT2045 - Trichome Head Colour and Robustness - 6 Months



ZT2045 - Undesirable (microseed) - 6 Months

ZT2045 - Undesirable (microseed) - 6 Months