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Occurrence of tropane alkaloids in teas. Effect of tea making on atropine and scopolamine

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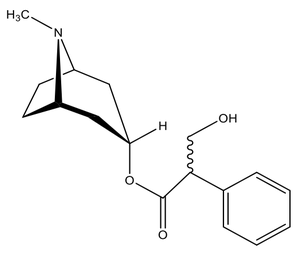
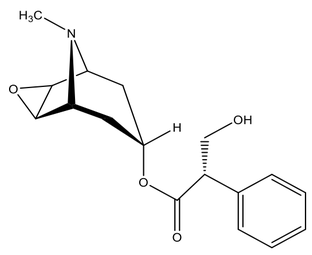
INTRODUCTION & AIM

Atropine and scopolamine, natural toxins from the tropane alkaloids (TAs) family, pose significant concerns due to their occurrence in food poisoning events. These alkaloids, found in various toxic plant families, such as Solanaceae and Brassicaceae, primarily affect those consuming contaminated plant-based foods, with cereals, teas, and herbal teas being commonly contaminated. The European Union has imposed maximum limits on these toxins in certain foods. Despite existing knowledge, many questions remain unanswered, particularly regarding toxin occurrence in associated weeds and their transfer to food products like teas. For this reason, this study aimed to analyze 33 teas and herbal teas commercialized in Spain and Portugal between 2021 and 2022 for atropine and scopolamine presence. The study also assessed the influence of tea brewing conditions on toxin levels. Such research is crucial for understanding and mitigating health risks associated with TAs contamination in herbal beverages.



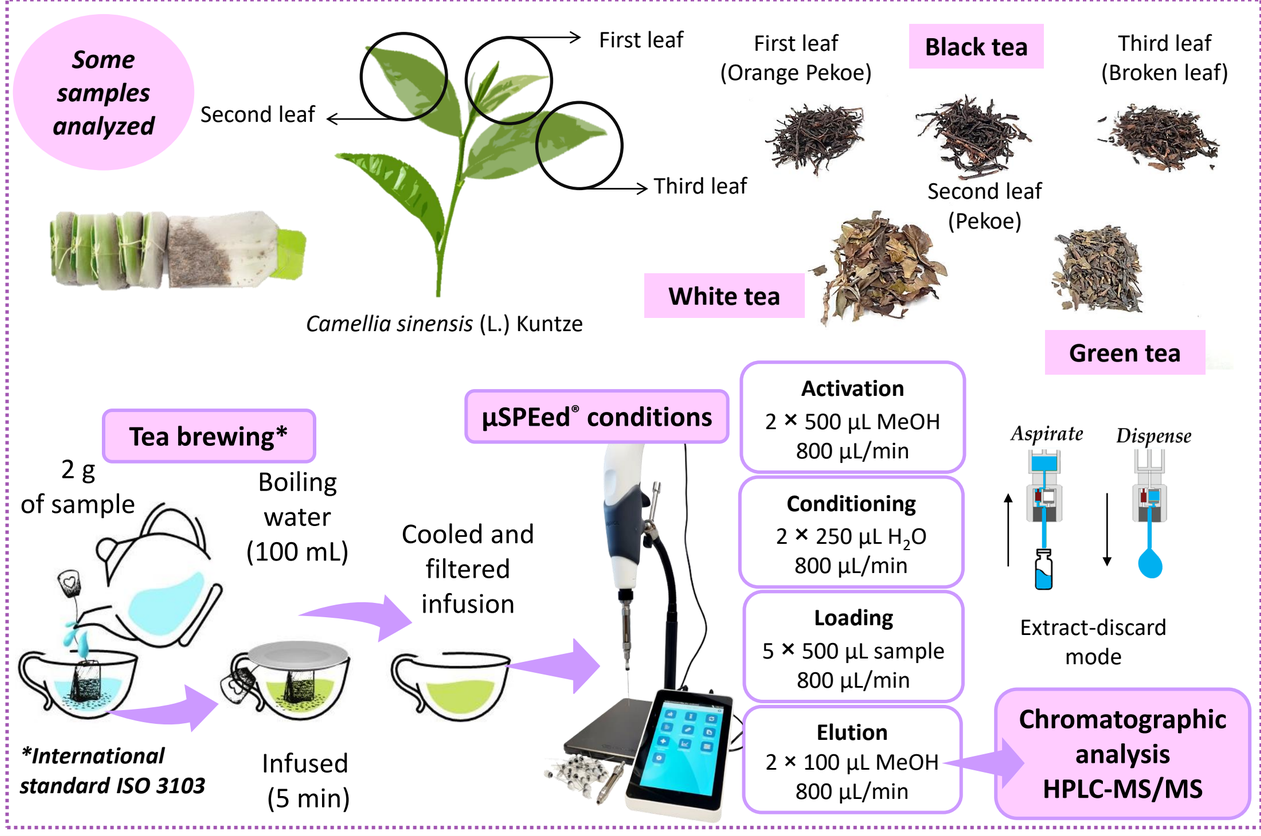
atropine or (±)-hyoscyamine

Most representative tropane alkaloids (TAs)



(-)-scopolamine or hyoscine

METHOD



RESULTS & DISCUSSION

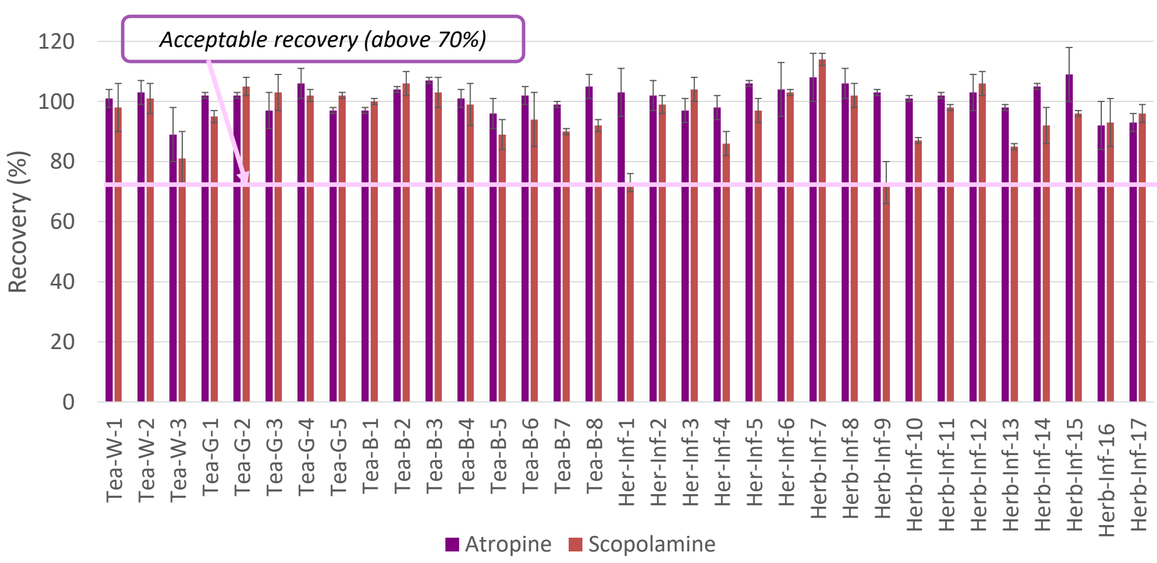


Figure 1. Recovery percentages for all infusion samples studied (n = 3) were evaluated using the µSPEed® protocol at a concentration of 2.5 ng/mL.

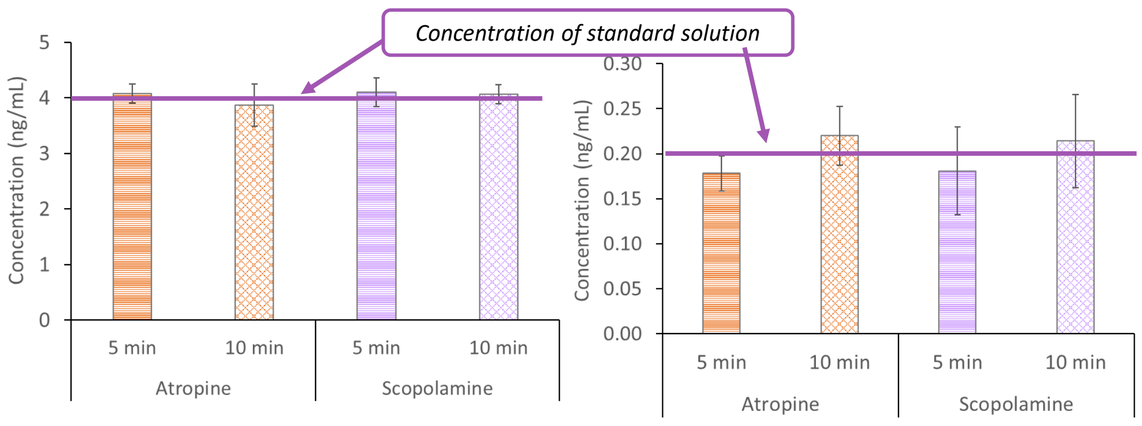


Figure 2. Effect of heating (97 ˚C maintained for 5 and 10 min) on atropine and scopolamine standard solutions (n = 3) at concentrations of (a) 4 ng/mL and (b) 0.2 ng/mL.

Table 1. Contents of atropine (At) and scopolamine (Sc) in the tea infusions analyzed.

Infusion code	Sample description	At (ng/mL ± SD)	Sc (ng/mL ± SD)
Tea-W-1[a]	White tea	2.57 ± 0.28	0.33 ± 0.02
Tea-W-2[a]	White tea	1.24 ± 0.14	0.33 ± 0.04
Tea-W-3[a]	White tea	2.86 ± 0.12	ND
Tea-G-1[a]	Green tea	3.65 ± 0.10	0.34 ± 0.02
Tea-G-2[a]	Green tea	4.65 ± 0.57	ND
Tea-G-3[a]	Green tea	4.94 ± 0.74	≤ MQL
Tea-G-4[a]	Green tea	4.15 ± 0.24	ND
Tea-G-5[a]	Kukicha green tea	≤ MQL	ND
Tea-B-1[a]	Black tea	1.81 ± 0.14	ND
Tea-B-2[a]	Black tea	1.65 ± 0.07	ND
Tea-B-3[a]	Black tea	1.30 ± 0.16	ND
Tea-B-4[a]	Black tea with bergamot	1.95 ± 0.08	ND
Tea-B-5[a]	Black tea	2.00 ± 0.16	ND
Tea-B-6[a]	Black tea	0.44 ± 0.05	ND
Tea-B-7[a]	Pakistani black tea	1.74 ± 0.08	ND
Tea-B-8[a]	Black tea	0.75 ± 0.03	ND

[a]Internal standard calibration curves using Tea-B-3 as the matrix for the quantification (Linear range: 0.1-25 ng/mL in infusion sample): At (y=0.022×+0.009, R^2 0.999) and Sc (y=0.028×-0.045, R^2 0.994); ≤ MQL: below or equal to the limit of quantification of the method (0.14 ng/mL for atropine and 0.18 ng/mL for scopolamine), ND: Not detected.

Table 2. Contents of atropine (At) and scopolamine (Sc) in the herbal tea infusions analyzed.

Infusion code	Sample description	At (ng/mL ± SD)	Sc (ng/mL ± SD)
Her-Inf-1[a]	Pink lapacho bark tea	ND	ND
Her-Inf-2[a]	Lemon grass tea	ND	ND
Her-Inf-3[a]	Rosemary	ND	ND
Her-Inf-4[a]	Valerian	≤ MQL	ND
Her-Inf-5[a]	Echinacea	ND	ND
Her-Inf-6[a]	Star anise	ND	ND
Herb-Inf-7[a]	Flavoured yerba mate	0.14 ± 0.01	ND
Herb-Inf-8[a]	Flavoured yerba mate	≤ MQL	ND
Herb-Inf-9[a]	Mixed herbal tea	<MQL	ND
Herb-Inf-10[a]	Mixed herbal tea	ND	ND
Herb-Infa-11[a]	Mixed herbal tea	<MQL	ND
Herb-Infa-12[a]	Mixed herbal tea	ND	ND
Herb-Infa-13[a]	Mixed herbal tea	ND	ND
Herb-Infa-14[a]	Mixed herbal tea	ND	ND
Herb-Inf-15[a]	Mixed herbal tea	ND	ND
Herb-Inf-16[a]	Mixed herbal tea	ND	ND
Herb-Inf-17[a]	Mixed herbal tea	ND	ND

[a]Internal standard calibration curves using Her-Inf-4 as the matrix for the quantification (Linear range: 0.1-25 ng/mL in infusion sample): At (y=0.025×+0.075, R^2 0.998) and Sc (y=0.028×-0.092, R^2 0.999); ≤ MQL: below or equal to the limit of quantification of the method (0.06 ng/mL for atropine and 0.18 ng/mL for scopolamine), ND: Not detected.

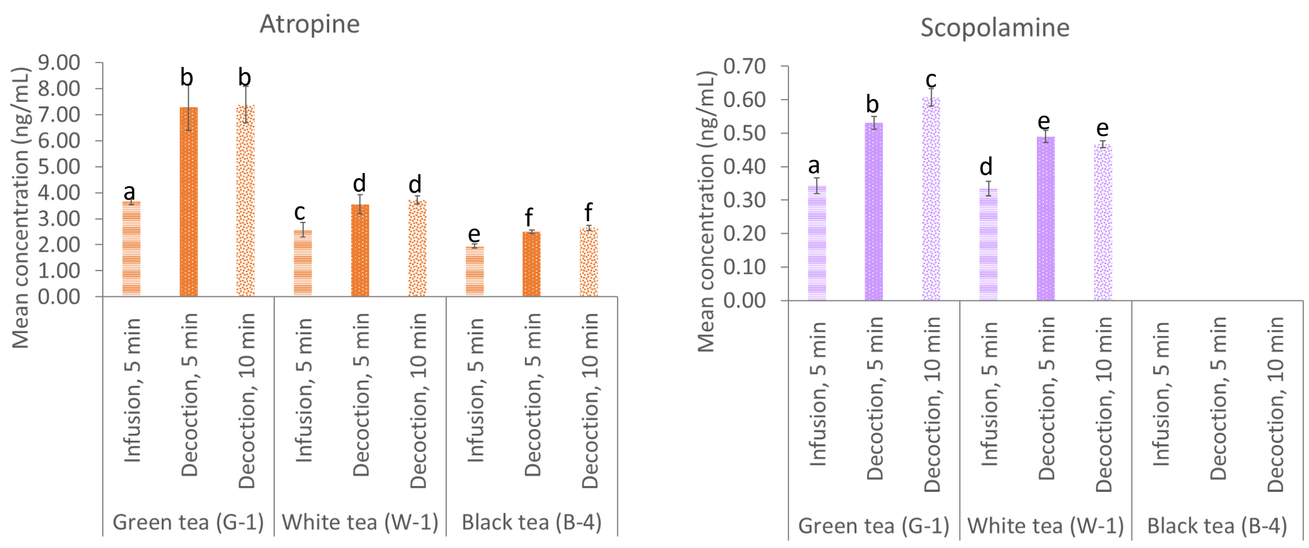


Figure 4. Impact of brewing parameters on the preparation of tea using green (G-1), white (W-1), and black (B-4) tea samples naturally contaminated with atropine and scopolamine: infusion with water at 97 ˚C followed by cooling (5 min), or decoction at 97 ˚C for 5 and 10 min. ANOVA analysis was conducted, and Duncan's test revealed identical letters in the figure denoting no statistically significant variances, while different letters indicate significant differences ($p \leq 0.05$)

CONCLUSION

This study investigated the presence of atropine and scopolamine in infusion samples using a µSPEed® protocol. Results showed 64% of samples were contaminated with TAs, underscoring the necessity for strict food control measures. Standard TA solutions demonstrated resistance to 97˚C in short times (up to 10 min), suggesting no degradation during brewing. However, infusion with boiling water (decoction) for 5 and 10 minutes resulted in increased extraction of atropine and scopolamine from the dry tea into the brewing water. Assessing TAs in infusions, not dry herbs, is recommended to avoid overestimation. Brewing parameters such as time and temperature influence TAs transfer, emphasizing the importance of following manufacturer instructions for accurate consumer exposure assessment.

REFERENCES

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2.González-Gómez, L.; et al. I. Evaluation of Tropane Alkaloids in Teas and Herbal Infusions: Effect of Brewing Time and Temperature on Atropine and Scopolamine Content. Toxins 2023, 15, 362. https://doi.org/10.3390/toxins15060362