



Innovative and sustainable food ingredients and products

Development of a chewing gum with *Actinidia arguta* extract as an innovative mitigation strategy for firefighters' occupational exposure

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Introduction

- Firefighters are exposed to several persistent organic pollutants including polycyclic aromatic hydrocarbons (PAHs), brominated flame retardants (BFR), among others [1].
- In 2022, IARC reclassified the occupational activity of firefighting as carcinogenic to humans (Group 1) [1].
- Most available mitigation strategies focus on better quality and fire resistance of personal protective equipment (PPE) and decontamination procedures of PPE [2].



There is a scientific and technological demand for mitigation strategies for occupational exposure.

[1] IARC Monographs on The Evaluation of Carcinogenic Risks to Humans. International Agency for Research on Cancer (2022)132, Lion, France.

[2] Horn, Gavin P et al. Journal of occupational and environmental hygiene vol. 19,9 (2022): 538-557.

Overview

The proposed invention

Essential oil



- Capacity to **retain the lipophilic pollutants**
- Provides pleasant aroma to the product



Chewing gum (CG) as mitigation strategy

Advantages

- Easy-use
- Affordable
- Sustainable

Dry kiwiberry (*Actinidia arguta*)



- Anti-inflammatory and antioxidant effect may offer protection against the pollutants.
- Allows reuse of kiwiberry that are not commercialized



Main Objectives

1. CG development

2. CG characterization

3. Pollutant Removal Efficiency by the CG



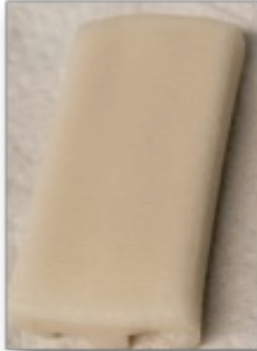



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CG development (The formulations)

Formulations		CGR	CGA	CGB	CGC
Appearance					
Composition	Essential oil	0.6%	0.6%	0.8%	0.8%
	Dry kiwi	Not present	0.2%	Not present	2%

CG-Chewing Gum*

The formulations were developed in collaboration with Lusiteca- Produtos Alimentares PA.



Main Objectives

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3. Pollutant Removal Efficiency by the CG

Texture Profile Analysis (TPA)



Rheologic Analysis (RA)



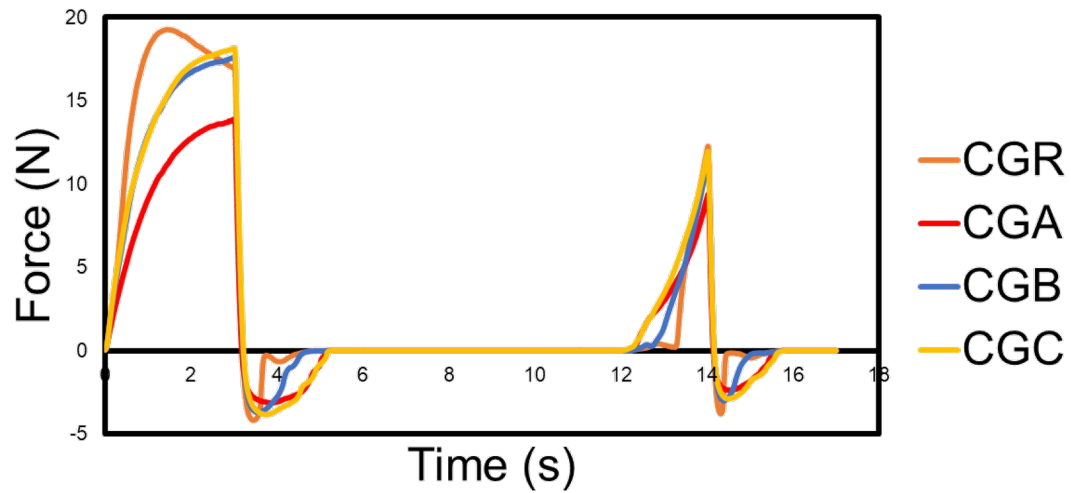
Sensorial Analysis (SA)*



** The SA was conducted with a panel of military firefighters from the Special Protection and Relief Unit of the Republican National Guard.*

CG Characterization (TPA)

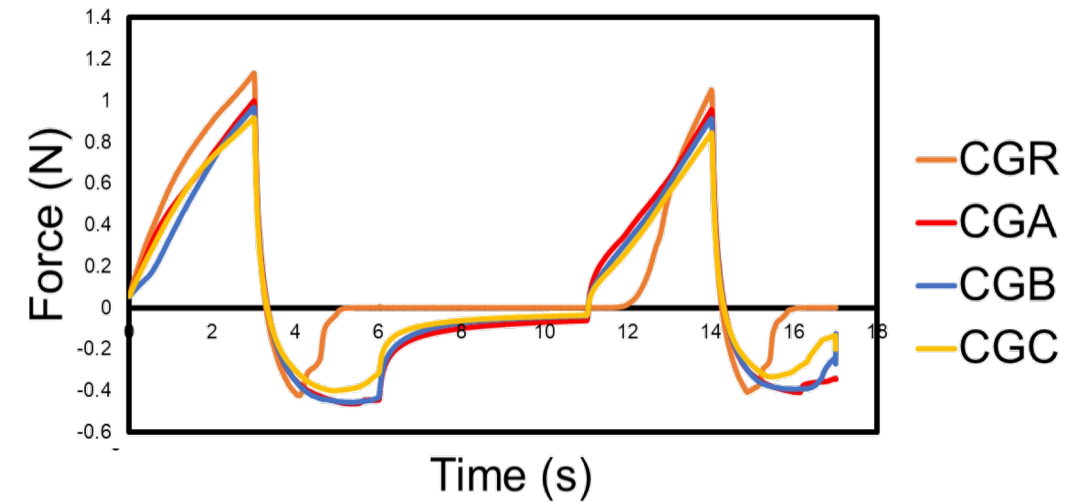
Textural Profile Analysis
(Dry CG)



After 10 minutes
of chewing



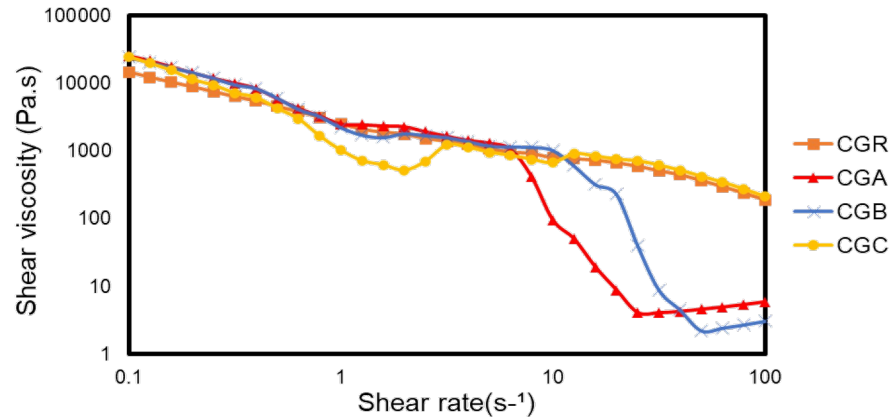
Textural Profile Analysis
(Chewed CG)



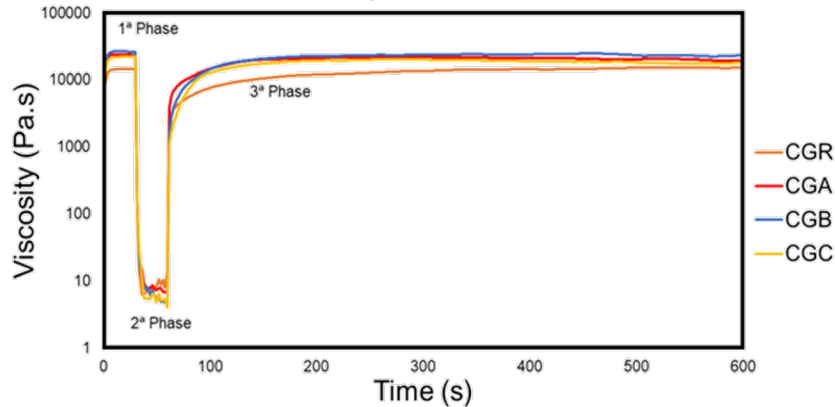
- All CG formulations display very **similar texture profiles**
- After chewing similarity increases

CG Characterization (RA)

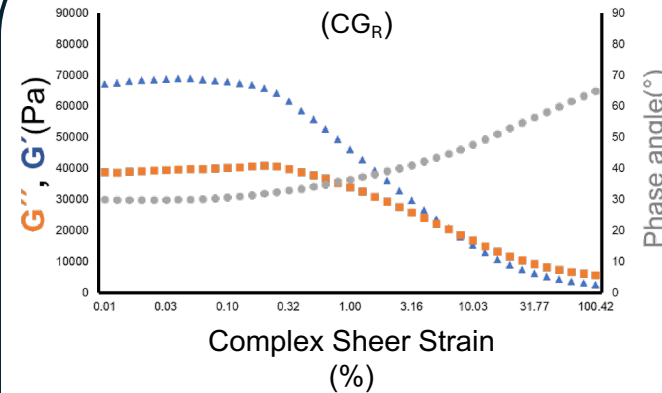
Amplitude Sweep Test



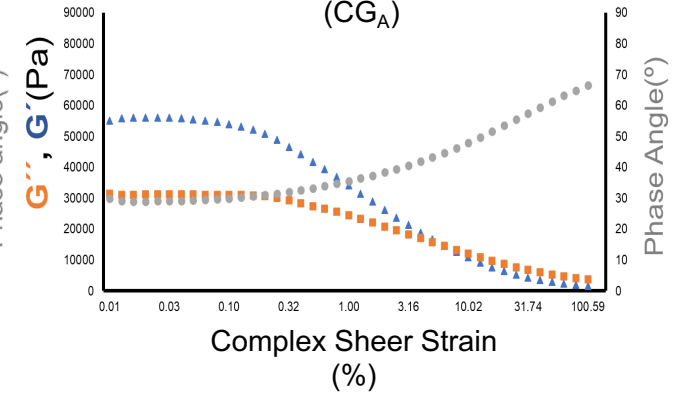
Three Step Shear Rate Test



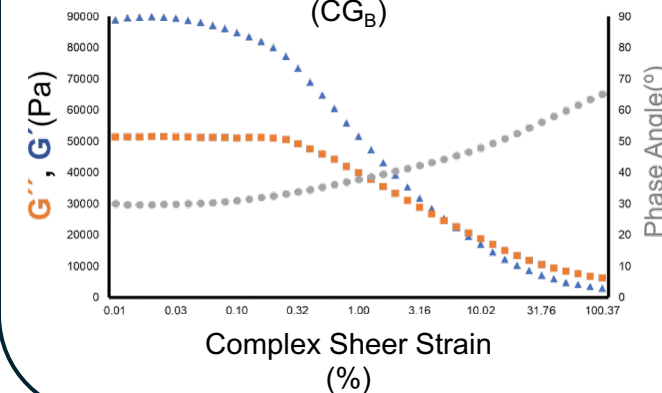
Linear Viscoelastic Region
(CG_R)



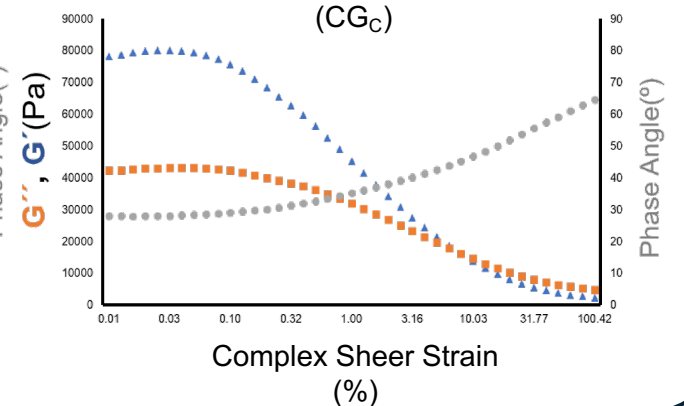
Linear Viscoelastic Region
(CG_A)



Linear Viscoelastic Region
(CG_B)

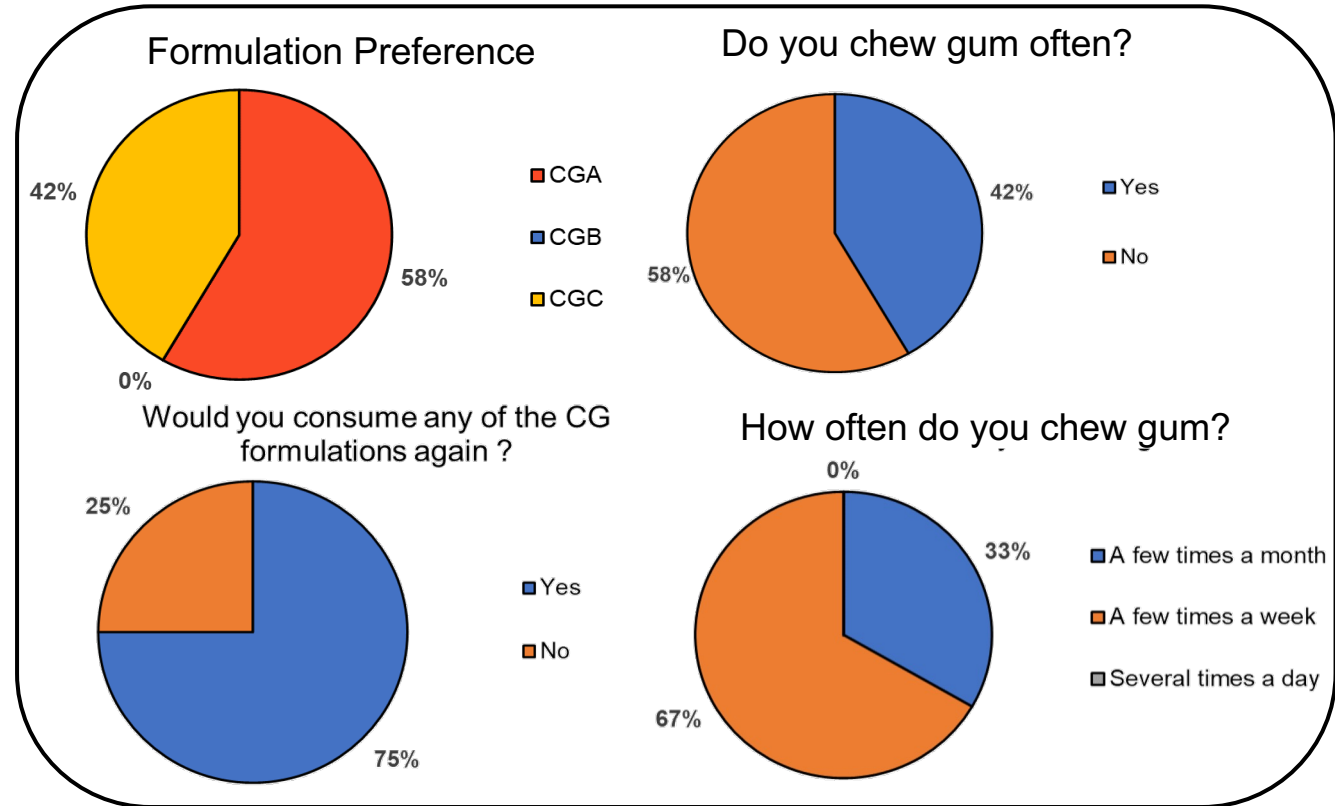
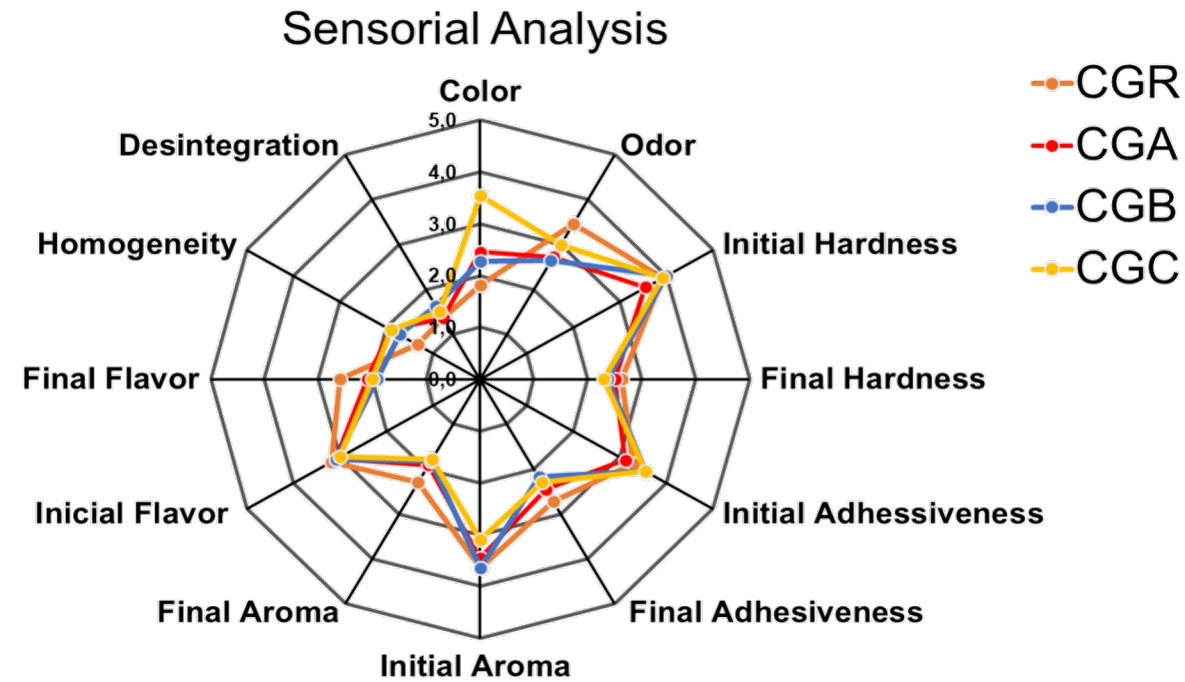


Linear Viscoelastic Region
(CG_C)



- After chewing, test formulations display **similar texture profiles and elastic behavior** within the linear viscoelastic region.
- All formulations display **shear thinning behavior with slight thixotropy**.

CG Characterization (SA)



- SA results indicated that **CG_A** and **CG_C** are the preferred formulations
- Hardness and Adhesiveness correlate with the TPA results



Main Objectives

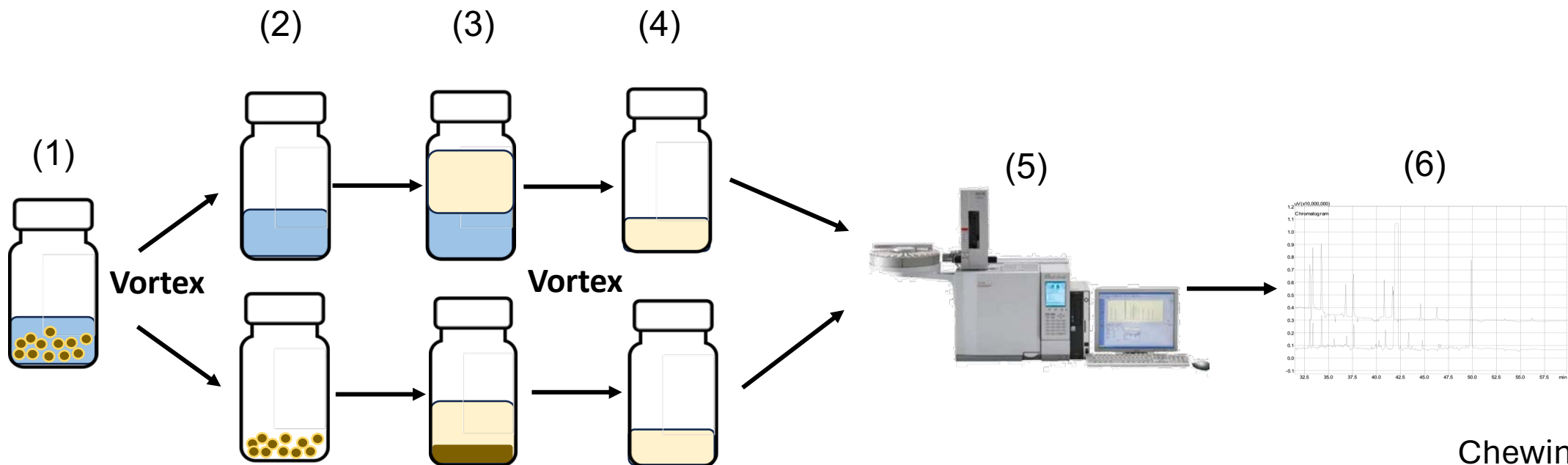
1. CG development

2. CG characterization

3. Pollutant Removal Efficiency by the CG

Pollutant Removal Efficiency by the CG (Methodology)

General Procedure – Simulations with CG and Artificial Saliva



- Steps**
- (1) CG is contaminated with standard solution of 7 BFRs and 17 PAHs
 - (2) Saliva and CG are separated
 - (3) *n*-Hexane or Acetonitrile is added as extraction solvents
 - (4) Extracts are concentrated
 - (5) Extracts are analyzed via HPLC or Gas chromatography (GC)
 - (6) Chromatograms are collected

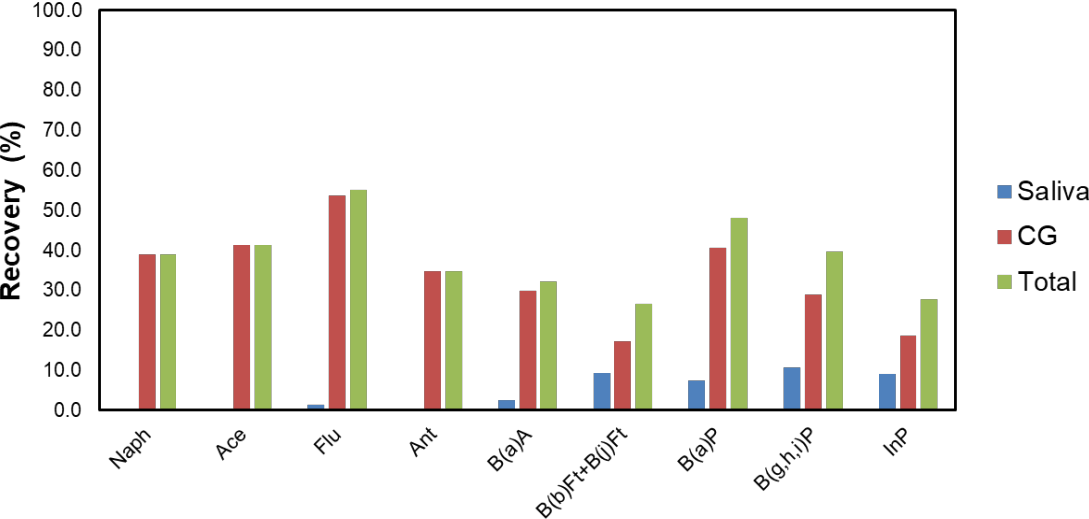
PAHs		BFRs
Naph	B(a)A	BDE28
Acen	Chry	BDE47
Ace	B(b)Ft+B(j)Ft	BDE100
Flu	B(k)Ft	BDE99
Phe	B(a)P	BDE154
Ant	DB(a,l)P	BDE153
Fln	DB(a,h)A	BDE183
Pyr	B(g,h,i)P	
	InP	

Chewing simulation



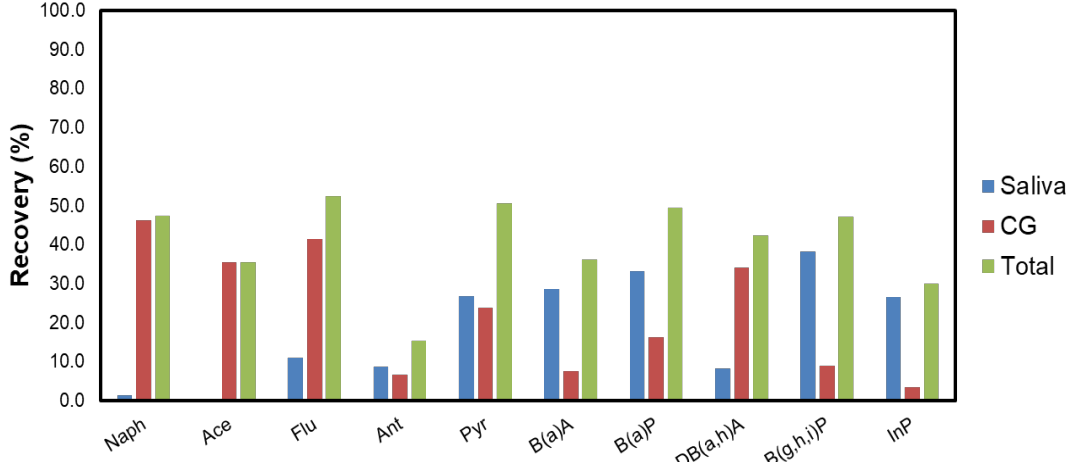
Pollutant Removal Efficiency by the CG (HPLC)

CGA



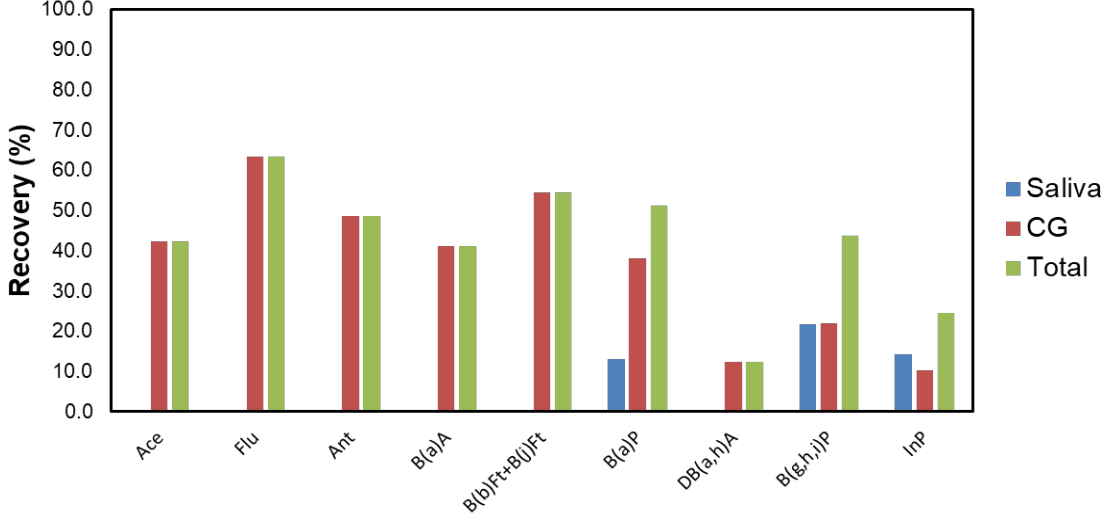
PAHs

CGC



PAHs

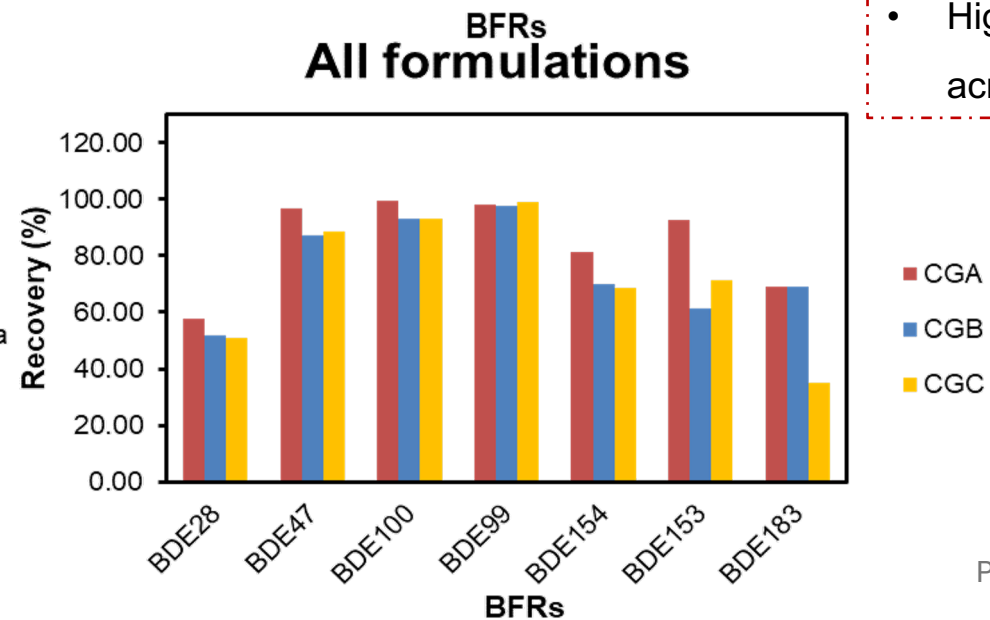
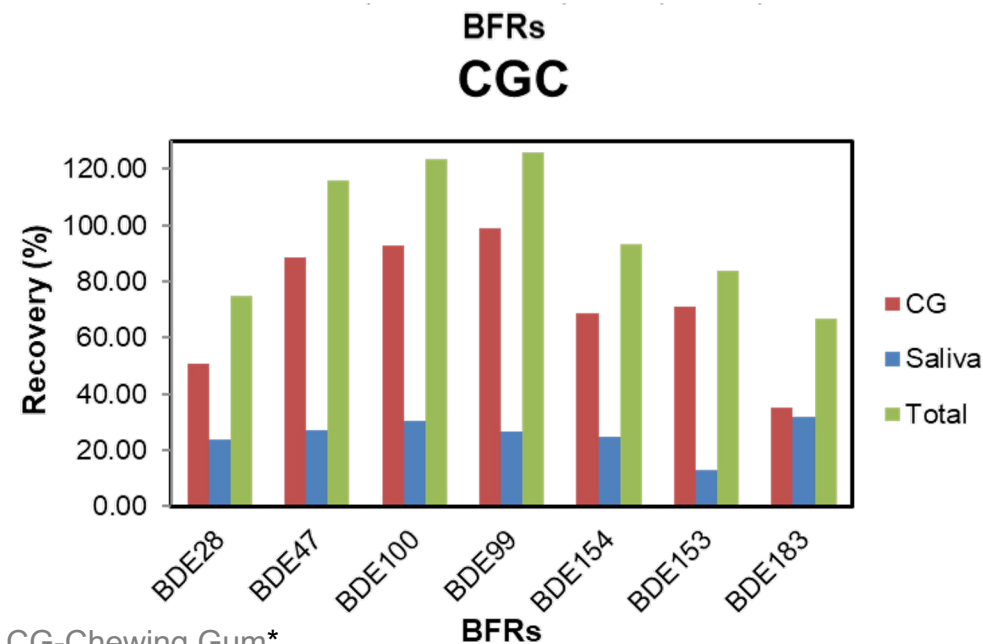
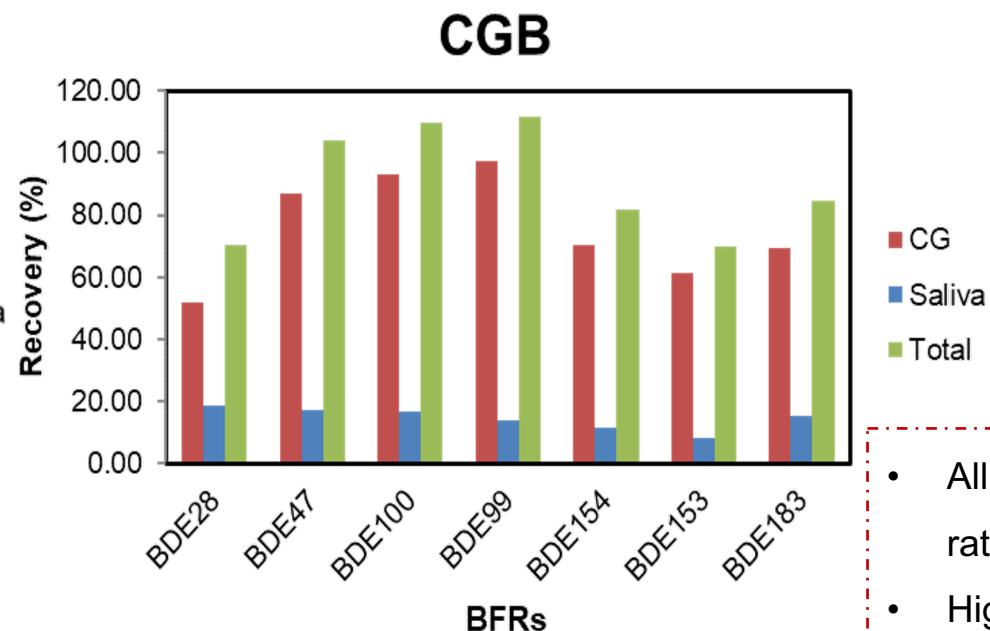
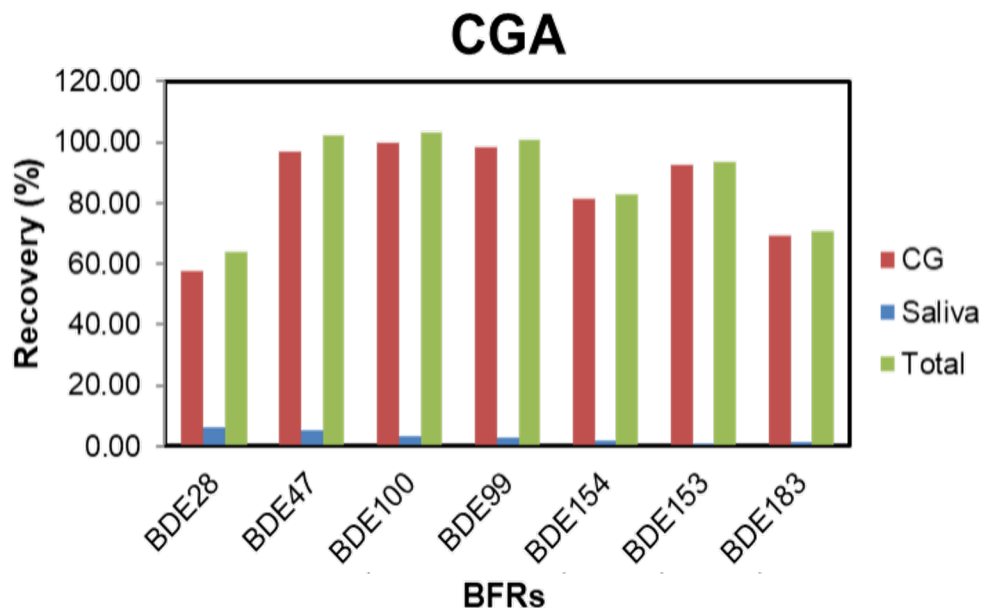
CGB



PAHs

- The CG' formulations were capable of retain up to 10 PAHs.
- Overall, CGA and CGB exhibited higher recoveries values.

Pollutant Removal Efficiency by the CG (GC)



- All CG' formulations display retention rates of 7 BFRs compounds.
- High recoveries can be observed across all formulations.

Conclusions and Future Perspectives

Main Conclusions

- All formulations reveal very similar texture profiles and rheological behavior.
- The CG showed good acceptability of the participants.
- The CG reveals promising retention of several BFRs.
- Overall, the analytical requires further optimization to obtain PAH higher recoveries.



Future Perspectives

- All formulations will be used by participants during 2024 firefighting activities to evaluate the presence of fire-related pollutants in the oral cavity of firefighters.
- In the future, the protective capacity of the dry kiwiberry extract will be evaluated through *in-vitro* cell assays.



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<https://doi.org/10.54499/2020.01886.CEECIND/CP1596/CT0001>

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Thank you for listening!

Any questions?

