

# Gummy Innovation: Development and Characterization of Plant-Based Gummies as Healthier Alternatives

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## INTRODUCTION & AIM

### Global Challenge

The growing population (projected to reach 9.1 billion by 2050), will increase food demand. Concurrently, there is a global rising trend in overweight and obesity.

### Increase Production of Processed Foods Plus Urbanization and Changing Lifestyle

People consume more unhealthy convenience foods (high salt, free sugars, calorific and fats) while not eating enough plant-based foods such as vegetables, fruits and pulses.

### World Health Organization (WHO)

States that healthy diets rich in plant-based foods can help reduce the risk of some diseases. It therefore recommends consuming at least 400 g of fruit and vegetables per day, while limiting the intake of salt, fats and free sugars.

In this context, the following formulation elements may be considered:

- Agar-agar is a plant-based gelling, thickening, and stabilizing agent derived from red algae
- 100% vegetable-based drink (coconut)
- 100% fruit/vegetable juice (apple, orange, carrot, tomato, grape)



This study aimed to develop plant-based gummies and evaluate their physicochemical and sensory properties

## METHOD

Formulation:  
6 diferente  
flavored  
gummies

Two grams of agar-agar were incorporated into 200 mL of a 100% vegetable-based drink (coconut) or a 100% fruit/vegetable juice (apple, orange, carrot, tomato, grape) obtained from a commercial source.

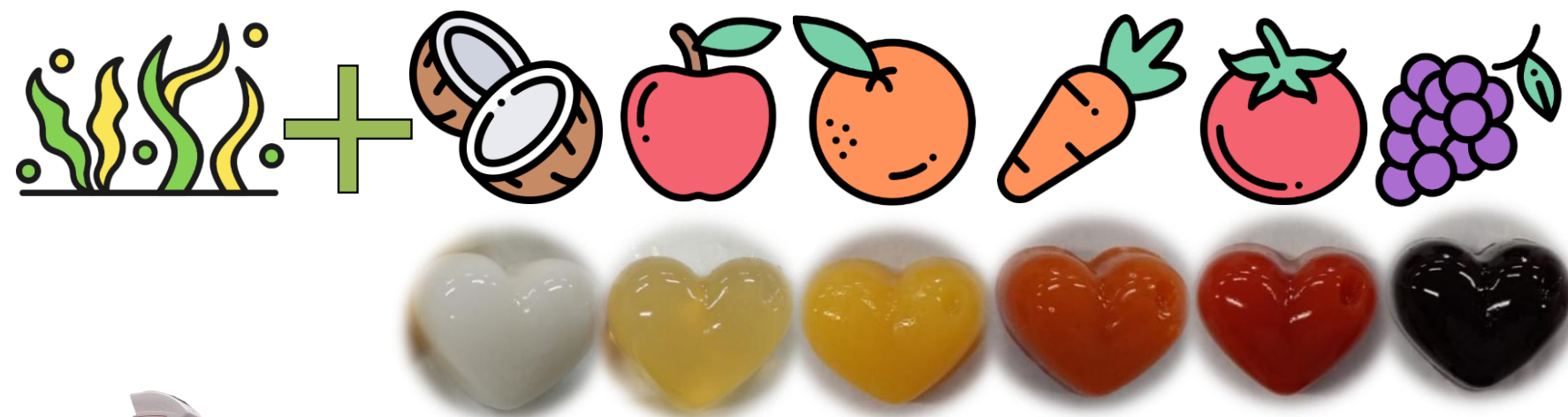


Image  
aquisition



A binocular magnifier (Leica Microsystems, Wetzlar, Germany) and Leica X software (LAS X) were used to capture detailed images.

Colorimetric  
analysis



A scanning spectrophotometric colorimeter (Agrosta, European Union), was used to measure color, covering the visible spectrum (ranging from 380 nm (violet) to 670 nm (red)).

pH analysis



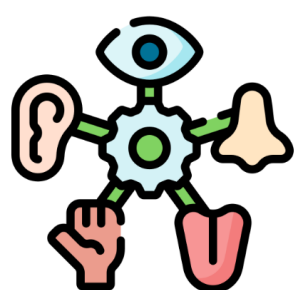
Measurements were conducted using a wireless pH meter equipped with a HALO FC2022 electrode (Hanna Instruments).

Total soluble  
solids analysis



The refractive index was determined prior to gum solidification, at around 50°C, with a refractometer (ATAGO, Japan).

Sensory  
analysis



A hedonic scale was used to assess sensory parameters including color, aroma, firmness, texture, taste and sweetness.

## RESULTS & DISCUSSION

### Image Aquisition and Colorimetric Analysis

Regarding **color** (Fig. 1, 2), the coconut-flavored gummies exhibited the highest transmittance values, consistent with their white color, while apple showed high values due to its transparency. More opaque gummies displayed lower transmittance. Grape- and tomato- flavored gummies showed contrasting tendencies, namely higher values at 450 nm (violet) and 650 nm (red) respectively.

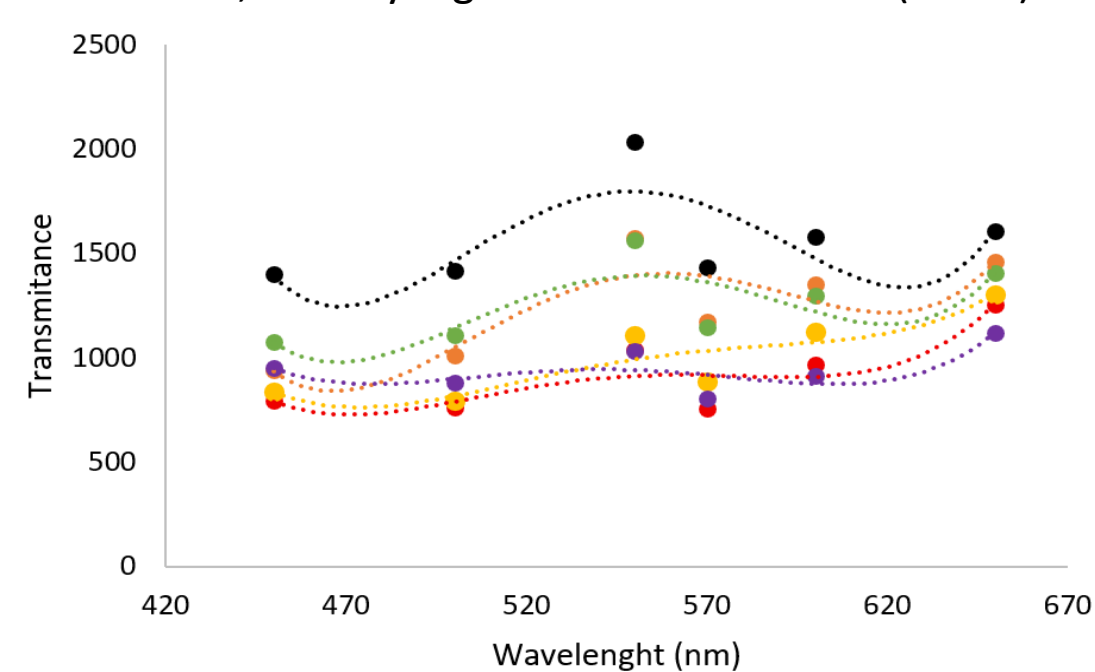


Fig. 1 – Visible spectra showing the average of transmittance of 6 differently flavored gummies

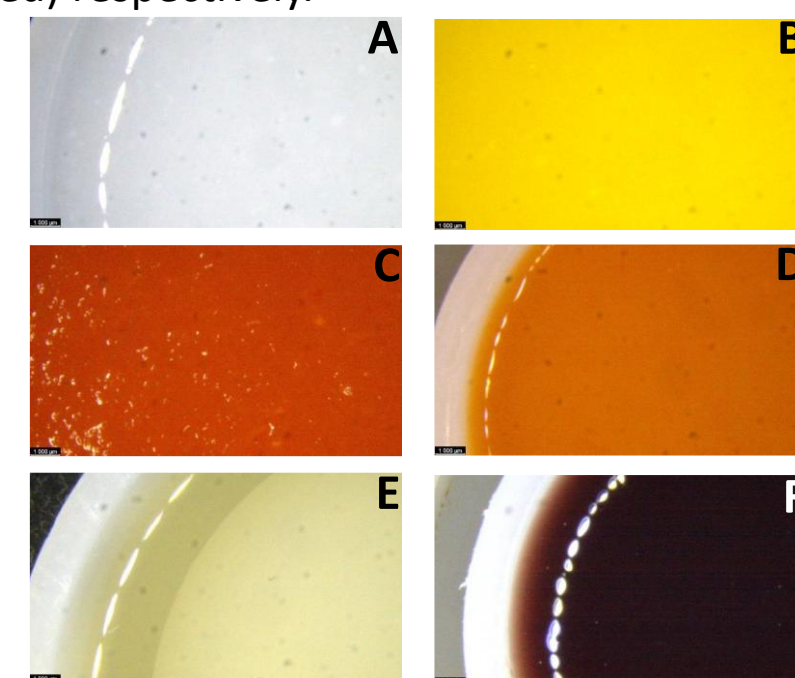


Fig. 2 – Images of gummies obtained with a binocular magnifier: (A) - coconut, (B) - orange, (C) - tomato, (D) - carrot, (E) - apple, (F) - grape.

### pH and Total Soluble Solids Analysis

The **pH values** (Fig. 3) varied between 3.42 – 7.09, with coconut-flavored gummies exhibiting the highest pH value among the formulations. This can be due to not only the pH values of the raw ingredients (with coconut containing lower concentrations of organic acids compared to the other fruits and vegetables) but also to processing factors, such as addition of lemon juice in the carrot- and tomato- flavored juices.

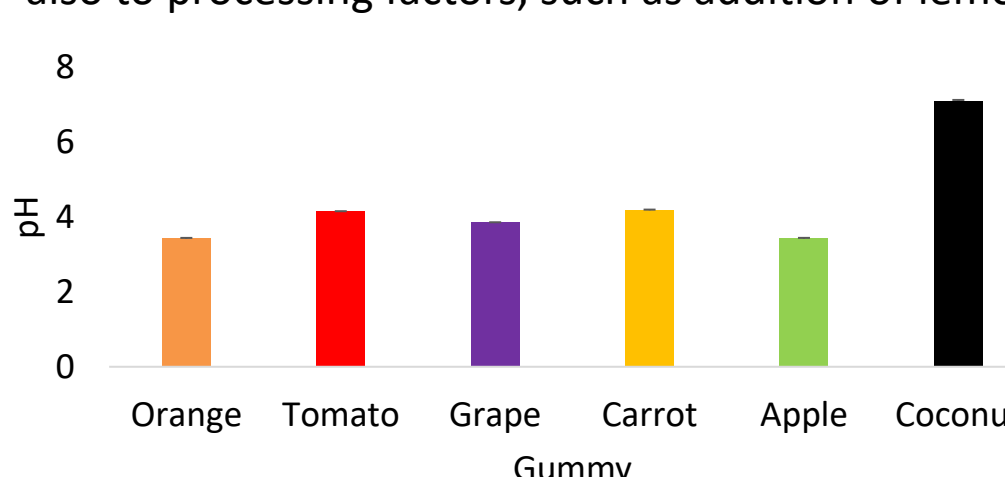


Fig. 3 – Mean values of pH of 6 diferente flavored gummies

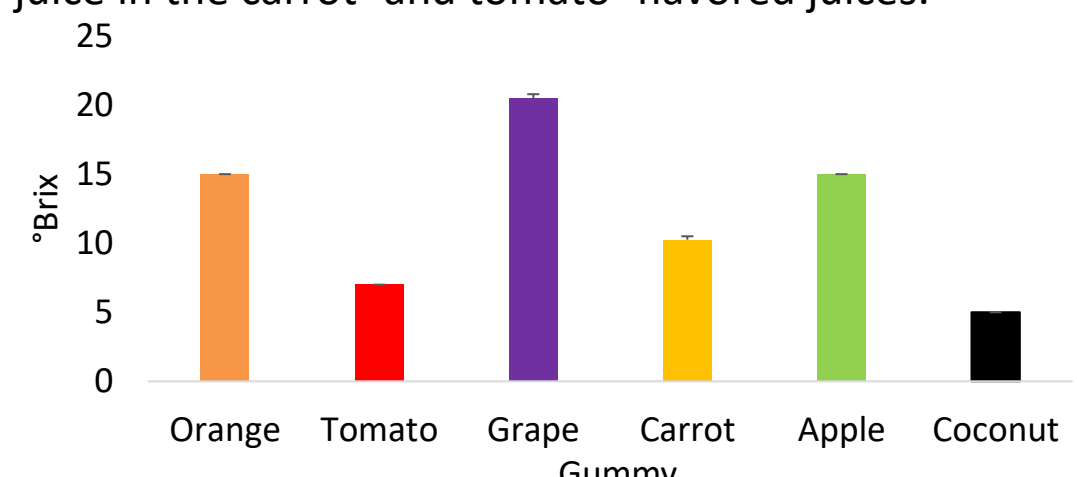


Fig. 4 – Mean values of total soluble solids of 6 diferente flavored gummies

The **total soluble solids** (Fig. 4) ranged from 5 to 21 °Brix, with the coconut- and grape- flavored beverages exhibiting the lowest and highest values, respectively. The two highest values aligned with consumers sensory perception (Fig. 5-F).

### Sensory Analysis

**Color-wise** (Fig. 5), coconut and orange formulations received the highest acceptance. Regarding **aroma** (Fig. 5), coconut and apple flavored gummies received higher evaluations. Similar scores for **texture** and **firmness** (Fig. 5) likely reflect the uniform processing of the gummy formulations with agar.

For **flavor** and **sweetness** (Fig. 5), grape and apple formulations were the most appreciated (to which total soluble solids may have contributed).

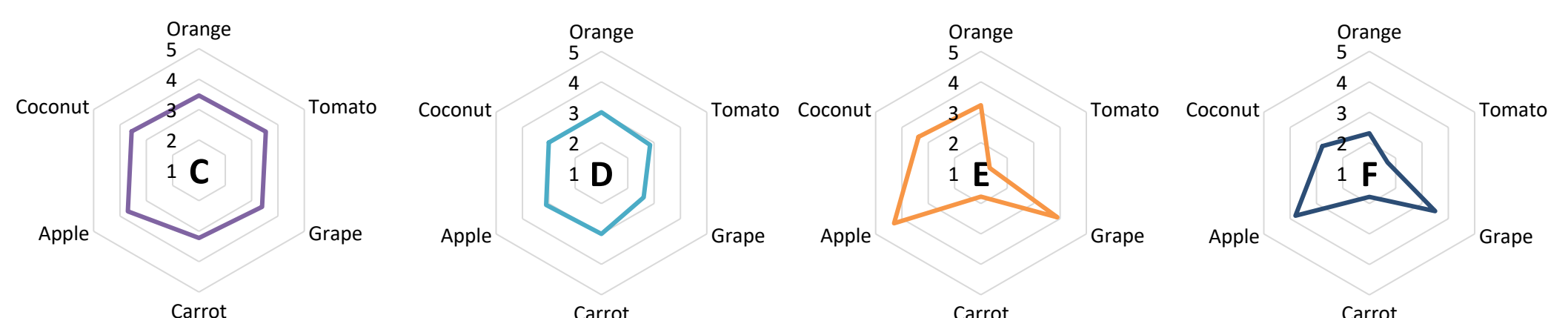


Fig. 5 - Sensory analysis of gummies, showing evaluations for color (A), aroma (B), Firmness (C), texture (D), taste (E), and sweetness (F)

## CONCLUSION

- The use of 100% fruit and vegetable beverages in gummies provides a foundation for innovation in plant-based product development.
- Among the formulation, apple- and grape- flavored gummies were the most preferred, while carrot- and tomato- flavored gummies were the least popular.
- These preferences corresponded closely with the scores of taste and sweetness.

## FUTURE WORK / REFERENCES

Cammarelle, A., et al. (2024). Consumers' behavior toward healthy foods: A critical review. Food Reviews International, 41(4), 1081–1098. <https://doi.org/10.1080/87559129.2024.2432927>