

# POLYPHENOLS:

By A. Lavie, J. Rabinowitz, and J. Xia  
Mentor: PhD Candidate Eden Eran Nagar  
Supervisor: Prof. Avi Shpigelman, Faculty of Biotechnology and Food Engineering, Technion

# WHAT IS THEIR FATE?

# MOTIVATION

Explore the digestive fate of polyphenols by measuring their stability and antioxidant capacity throughout digestion.

How the chemical structure of polyphenols affects their stability under certain gastrointestinal conditions.

Examine the effect of HPP on the antioxidant capacity of polyphenols.

# BACKGROUND

**INTRODUCTION** Polyphenols are organic molecules consisting of one or more benzene rings and hydroxyl groups, and are found mostly in fruits and vegetables. Due to their great antioxidant activity, they possess many health benefits and can prevent various diseases such as cancers, cardiovascular diseases, and osteoporosis.

**CHARACTERISTICS** Polyphenols are sensitive molecules, their structure being easily influenced by common environmental factors such as temperature, acidity, and the presence of light. Polyphenol-rich foods are commonly pasteurized by heating; this can degrade the polyphenols' molecular structure and impair their antioxidant capacity. During digestion, polyphenols are exposed to different acidity levels, enzymes, and temperatures which can greatly affect their stability.

**PROCESSING** High Pressure Processing (HPP) is a novel alternative to thermal processing. This processing method has been found to allow polyphenols to maintain their molecular structure more effectively than thermal processing, while still eliminating any microorganisms in the food.

# RESULTS

## The Effect of the Polyphenol Chemical Structure

### Sample Analysis

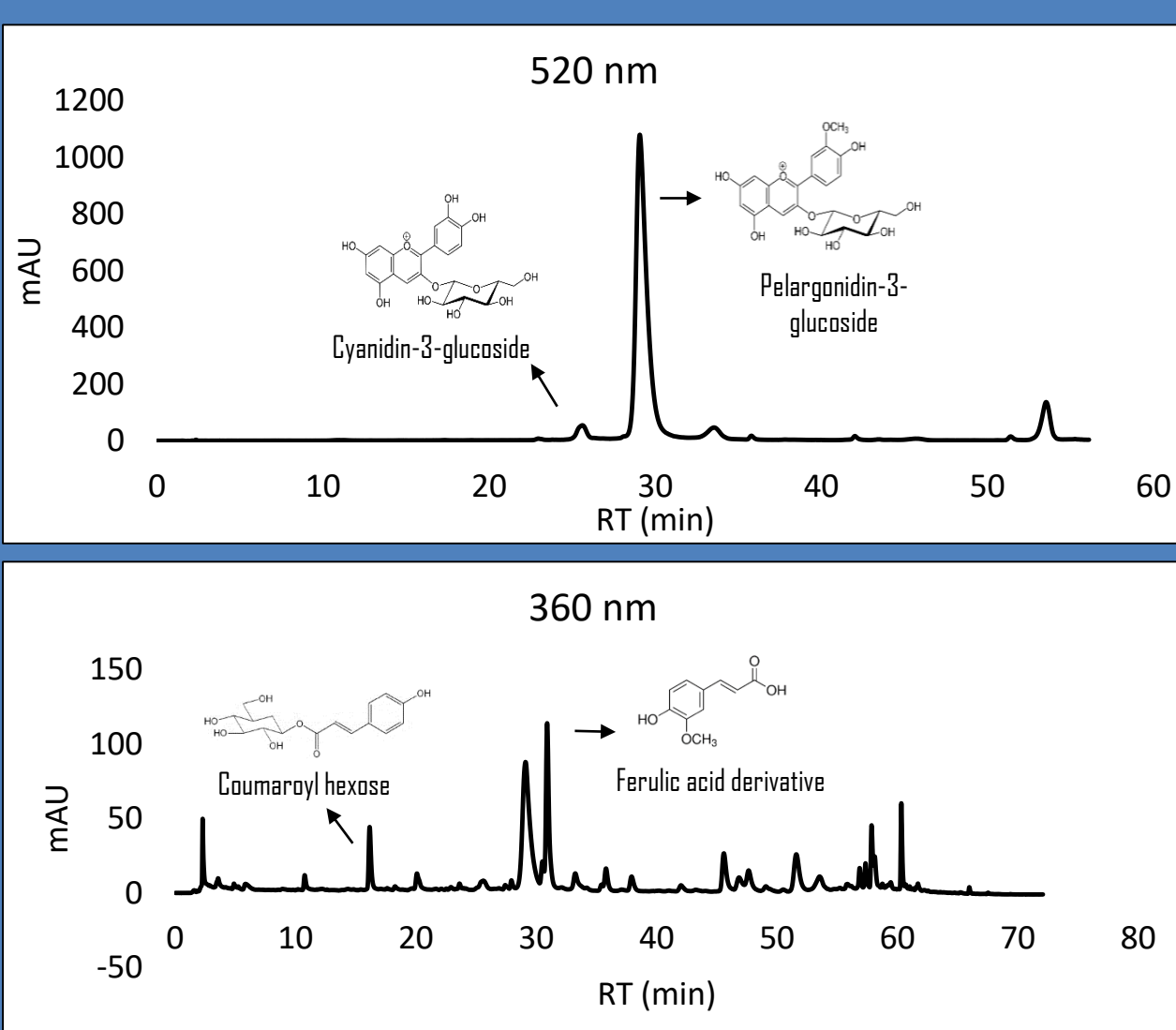


Fig. 1. Above are two chromatographs (at wavelengths 520 nm and 360 nm, respectively) of an unprocessed sample in the G20 phase, showcasing a variety of different polyphenols.

### Polyphenol Stability Throughout Digestion

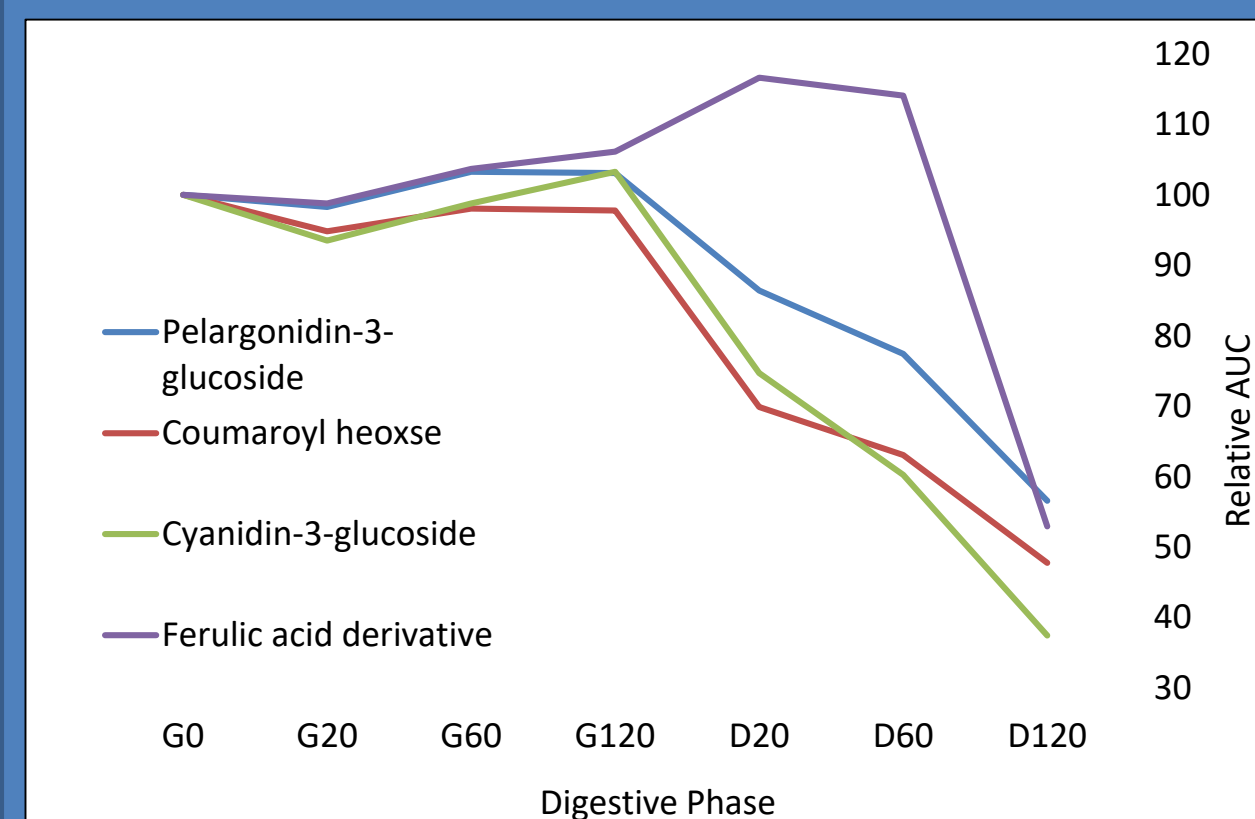


Fig. 2. Above is a graph displaying the relative stability of different polyphenols throughout the digestive phases, using HPLC analysis (Fig. 1). The digestive phases are labelled G and D for gastric and intestinal phases, respectively, with elapsed time as a subscript.

## Antioxidant Capacity of Unprocessed vs Processed Polyphenol Samples Throughout Digestion

### The FRAP ASSAY

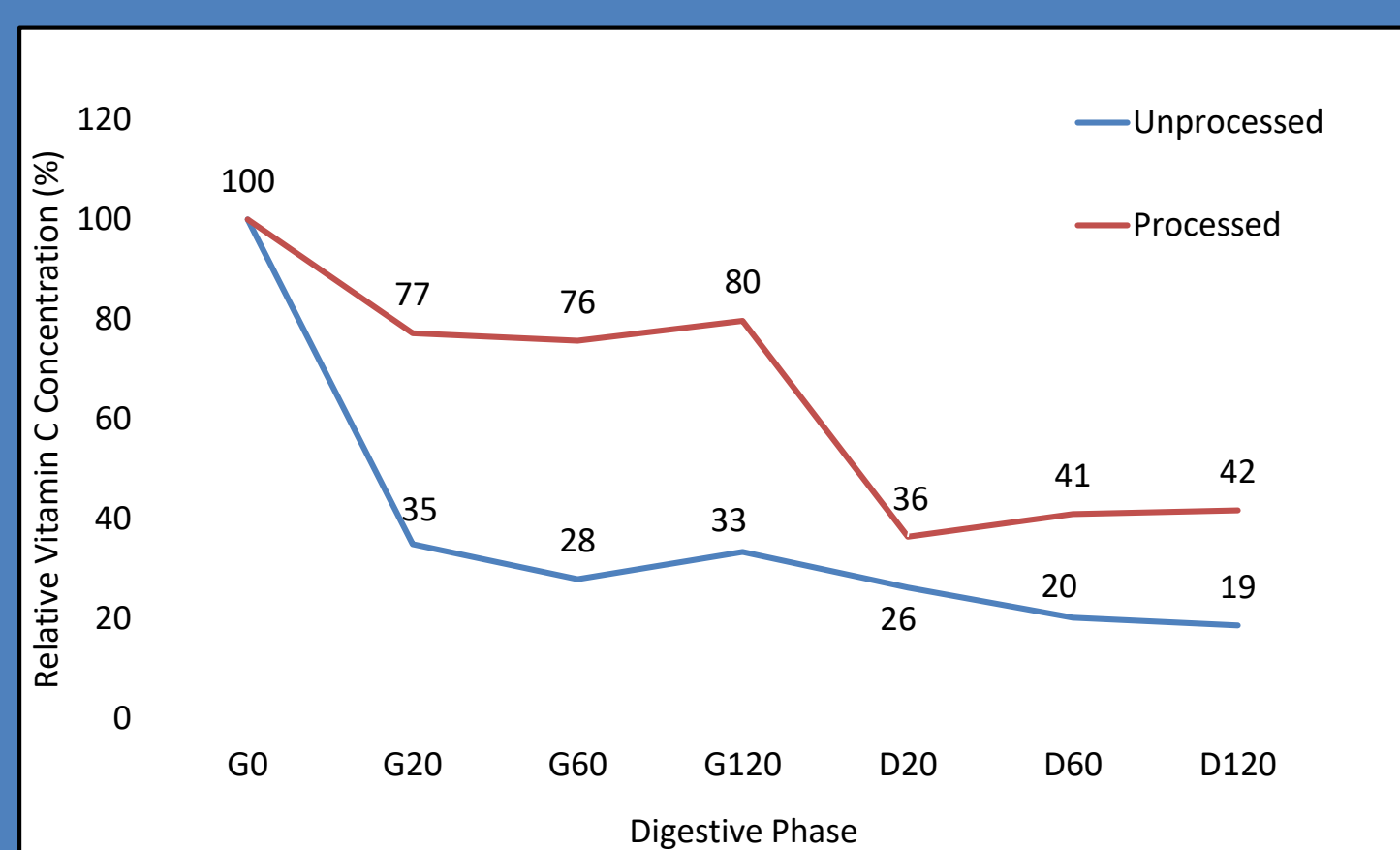


Fig. 3. Above is a graph displaying the FRAP results for the unprocessed and processed samples, relative to G0.

### The DRAC ASSAY

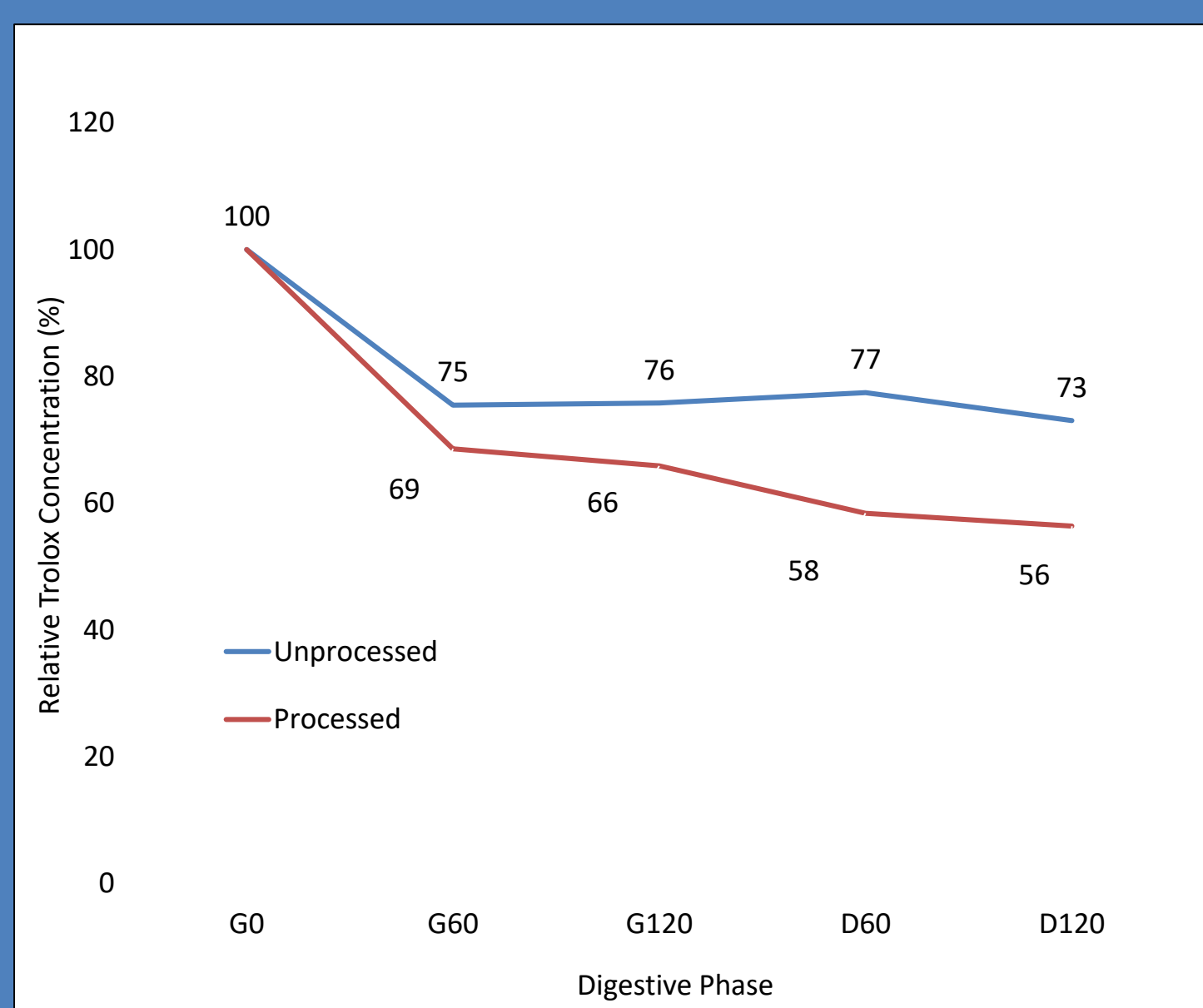


Fig. 4. Above is a graph displaying the DRAC results for the unprocessed and processed samples, relative to G0.

# EXPERIMENTAL DESIGN

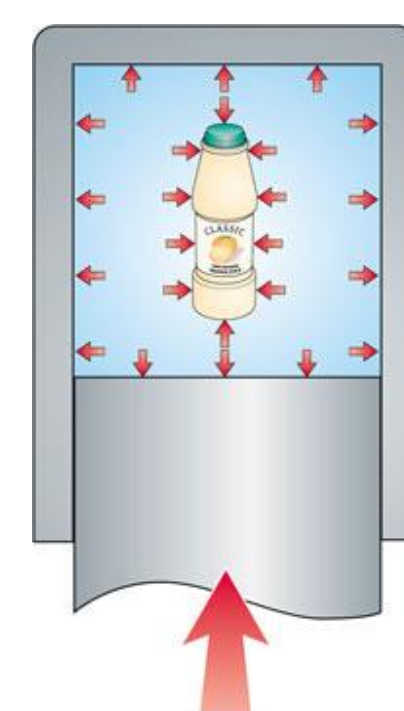
## SAMPLING

Polyphenol extraction from freeze-dried nerina strawberry powder.



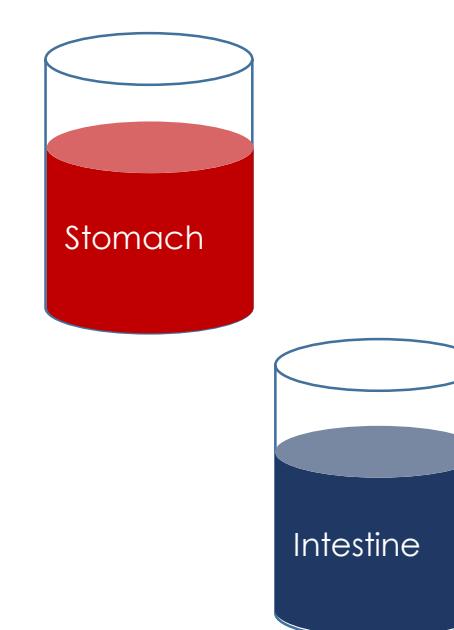
## PROCESSING

Pasteurization of half of the samples using HPP.



## DIGESTION

*In vitro* gastrointestinal digestion of the samples.



## TESTING

Analysis of polyphenol stability and their antioxidant activity.



# DISCUSSION

Generally, polyphenols remain stable during gastric digestion and degrade during intestinal digestion. This is probably due to pH differences in the stomach and intestine. Fig. 2

Although polyphenols from the same group share similar chemical structure, their stability throughout gastrointestinal digestion was different. Fig. 2

An increase in ferulic acid derivative free molecules was observed in the intestinal phase, perhaps due to aggregate separation due to higher pH. Fig. 2

The antioxidant level trend from the FRAP assay showed a decrease at the start of the gastric phase contrary to the polyphenol stability trend of the examined polyphenols, probably due to the contribution of other polyphenols to the antioxidant activity. Fig. 3

In the DRAC assay, the antioxidant activity of both the processed and unprocessed samples remained constant from G60. Relating this to the polyphenol stability trend, it is likely that the degradation products of the samples maintained significant antioxidant capacities. Fig. 4

# CONCLUSIONS

Polyphenols have changes in stability and antioxidant activity throughout different stages of digestion.

Chemical structure of polyphenols can dramatically affect their stability and fate in the gastrointestinal tract.

HPP can help polyphenols maintain their antioxidant activity throughout digestion.

# REFERENCES

Rodriguez-Roque, M. J., Arcos, B. D., Sanchez-Moreno, C., Cano, M. P., Elez-Martinez, P., & Martin-Belloso, D. (2015). Impact of food matrix and processing on the in vitro bioaccessibility of vitamin C, phenolic compounds, and hydrophilic antioxidant activity from fruit juice-based beverages. *Journal of Functional Foods*, 14, 33-43. doi:10.1016/j.jff.2015.01.020

Attri, S., Singh, N., Singh, T. R., & Goel, G. (2017). Effect of in vitro gastric and pancreatic digestion on antioxidant potential of fruit juices. *Food Bioscience*, 17, 1-6. doi:10.1016/j.fbs.2016.10.003

Giampieri, F., Alvarez-Suarez, J. M., & Battino, M. (2014). Strawberry and human health: Effects beyond antioxidant activity. *Journal of agricultural and food chemistry*, 62(18), 3867-3876.

# ACKNOWLEDGEMENTS

We would like to thank PhD student Eden Eran Nagar and Prof. Avi Shpigelman for hosting and guiding us through our research in his laboratory. We would also like to thank the foundations and donors for their generous support of the SciTech Program.