Software development to evaluate the stability of the plant protein formulations for food applications.

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Abstract

The demand for plant-based food products has increased dramatically in recent years, and this has resulted in the need for the development of high-quality plant protein formulations. One critical aspect of plant protein formulation is its stability, which can be challenging to evaluate using current methods that require specialized equipment and time-consuming manual analysis. Existing methods involve expensive equipment, such as the Turbiscan, or require manual analysis of sample images. To address this challenge, this project aims to develop a software tool for evaluating the stability of plant protein formulations using image analysis. The software development process involves coding the functions for image analysis by MATLAB and editing using other supportive image applications. The software will allow users to input images of plant protein samples and simulate the stability of the sample over time under various storage conditions. For example, it will be designed to analyze changes in the color and texture of plant protein samples over time. The resulting software tool will provide a cost-effective and efficient alternative to existing methods for evaluating the stability of plant proteins. The tool can be used by food manufacturers to assess the stability of their plant protein formulations, which will accelerate the development of high-quality, stable plant-based food products. The software can significantly benefit the food industry by providing a quick and accurate way to examine the sustainability of plant protein compositions without the need for specialized equipment or manual analysis. Overall, the development of an image analysis software tool for evaluating the stability of plant protein formulations has significant implications for the food industry and can contribute to meeting the growing demand for plant-based food options.

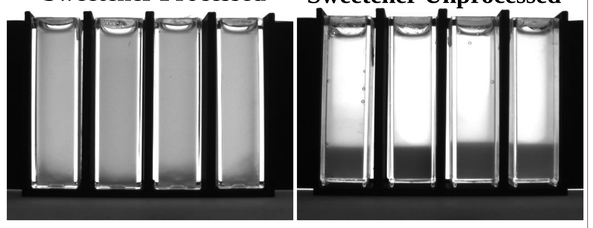
Background

Due to growing environmental and public health concerns, there has been substantial growth in the demand for plant-based food items in recent years. Because they are low in fat, cholesterol-free, and high in fiber and minerals, plant-based proteins have become a well-liked substitute for animal-based proteins. However, there are some difficulties in the formulation of plant-based proteins for use in food, including stability, texture, and flavor. The development of food products must take stability into consideration because it has an impact on the product's quality, safety, and shelf life. The images are recorded in two different groups of plant protein: one with sweetener processed, and another with sweetener unprocessed. During the development of the software using image analysis in MATLAB, I encountered some challenges. One of the main challenges was running the code for image acquisition and analysis, which required completing each task step by step. Additionally, I had to learn a new tool in MATLAB called ‘app designer’ to create a Graphical User Interface (GUI) for the software tool. This was a new and daunting task for me, but I persevered and was able to create an effective GUI. The benefit of this software tool is that it can be used by students or others who are not familiar with coding and cannot afford image-analyzing machines, as it offers a cost-effective and user-friendly alternative. Overall, despite the challenges I faced, the development of this software tool has proven to be an effective method for evaluating the stability of plant protein formulations using image analysis.

Materials and Methods

Testing the stability of Plant protein samples via 4 types of sweetener:

1. Sucrose
2. Aspartame
3. Rebaudioside-A
4. Maltitol



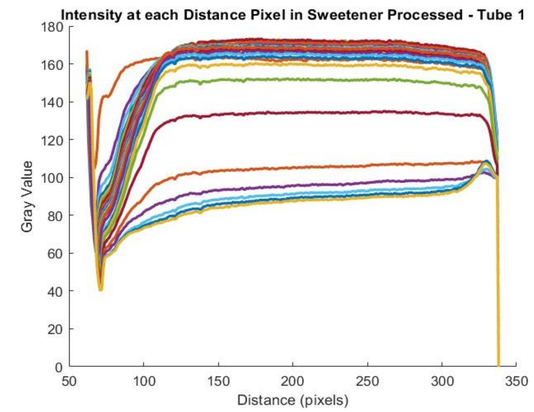
Camera setup for taking Images and Applications for Image Analyzing

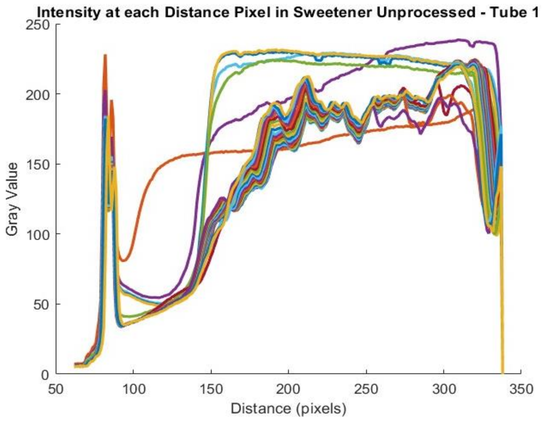
There are four tubes containing plant-based proteins recorded by a camera that is connected to a desktop. It takes pictures every 10 minutes for several months. The activity repeats twice for two sweetener processes.

MATLAB & AppDesigner

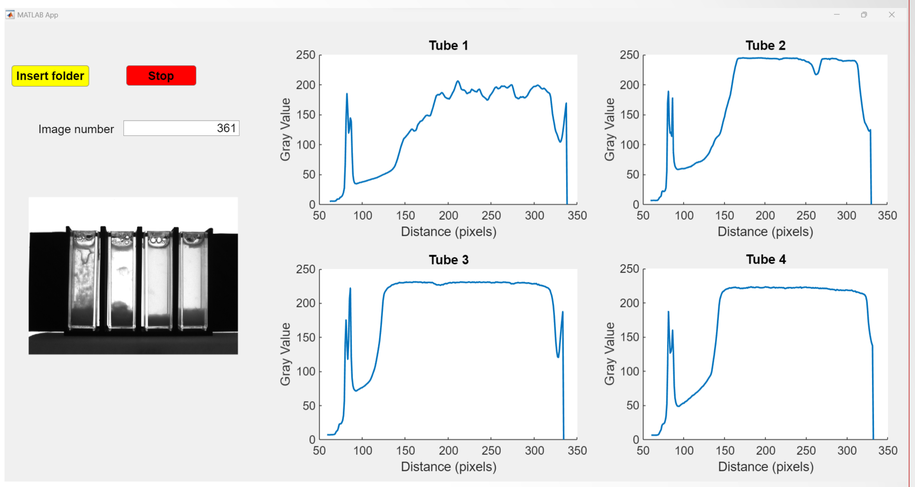
First using MATLAB to analyze the image from the input folder, training data. Then apply the code to App Designer to create a Graphic User Interface for Image Acquisition, Image Analysis, and export the results.

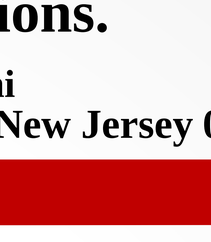
Coding Results





GUI Results





88	89	90	91	92	93	94
132.8971	104.8529	94.57353	89.91176	87.85294	86.86765	86.83824
127.1176	101.4559	91.51471	86.57353	84.38235	83.25	82.13235
124.6176	100.4412	90.57353	85.60294	82.98529	81.86765	80.58824
122.5882	98.16176	88.70588	83.57353	81.25	79.67647	78.66176
119.6618	97.25	87.88235	82.94118	80.58824	79.57353	78.07353
116.9853	95.41176	85.80882	81.08824	78.85294	77.66176	76.19118
118.7353	95.94118	86.10294	81.14706	79.29412	77.55882	76.57353
114.4118	93.29412	84.17647	79.48529	77.35294	76.27941	74.98529
116.8382	94.07353	84.38235	79.86765	77.72059	76.32353	74.70588
114.5441	92.23529	82.94118	78.57353	76.5	74.95588	73.48529
113.5294	92.33824	82.88235	78.47059	76.5	74.83824	73.35294
111.6765	90.22059	81.23529	76.61765	74.76471	73.41176	71.97059
112.2941	90.19118	81.69118	76.86765	74.64706	73.70588	72.30882
109.75	88.48529	80.14706	75.75	73.92647	72.26471	71.19118
107.8971	87.95588	79.79412	75.66176	73.60294	72.57353	70.97059
105.75	86.47059	78.29412	74.35294	72.79412	71.13235	69.80882
106.3676	86.42647	78.44118	74.41176	72.82353	71.20588	70.23529
104.0882	84.61765	76.69118	72.89706	71.52941	70.42647	69.07353

Conclusion

- enables users to input images of plant protein samples and simulate the stability of the sample over time under various storage conditions
- Automatically extract the plots to a new folder and intensity each ROI to CSV file
- provides a cost-effective and efficient alternative to existing methods for evaluating the stability of plant proteins
- can significantly benefit the food industry by providing a quick and accurate way to examine the sustainability of plant protein compositions without the need for specialized equipment or manual analysis

Future Direction

- Require additional validation and calibration or incorporate machine learning algorithms to ensure accuracy and consistency of results.
- Using a phone camera for image analysis is a feasible and cost-effective approach
- The software could be developed as a mobile app, allowing for easy access and use.

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