Assiut University
Faculty of Agriculture
Food Science and Technology Department

Utilization of Some Food Processing Wastes as a Source of Natural Pigments

By

Hamada Khalaf Hassan Megali

B.Sc. Agric. Sci. (Food Science and Technology)
Faculty of Agriculture, Assiut University (2010)

A THESIS
Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science

In Agricultural Sciences (Food Science and Technology)

Supervised by:

Prof. Dr. Soumia Mohamed Ibrahim Darwish (Main supervisor)
Professor of Food Science and Technology, Faculty of Agriculture, Assiut University.

Dr. Hassan Ismail Abd El-Hakim Ahmed
Senior Researcher at Food Technology Research Institute, Agricultural Research Center, Giza

Dr. Mokhless Ahmed Mohamed Abd-El-Rahman
Lecturer of Food Science and Technology, Faculty of Agriculture, Assiut University

2019

CONTENTS

LIST OF TABLES

LIST OF FIGURES

6. SUMMARY

Fruit and vegetable wastes and their by-products are remaining in great amounts during industrial processing and hence represent a serious problem, as they exert harmful impact on the environment. So, they need to be managed or they can be exploited. This study was performed to investigate the possibility of utilization of some food processing wastes to produce some natural pigments and using of these pigments for coloring some food products instead of artificial colors to avoid the bad effects on human health and to reduce pollution in the production lines during food manufacturing stages. In this investigation three raw materials were used, as food processing wastes, namely purple carrot pomace (as a source of anthocyanin pigment), Tomato peels (as a source of lycopene pigment), and orange peels (as a source of β-carotene pigment). This can be illustrated by the results that could by summarized as follows:

- **Chemical composition of purple carrot pomace, orange and tomato peels.**

The results showed that purple carrot pomace had approximately the highest total carbohydrate content recorded 77.71 % followed by tomato and orange peels (72.24 and 68.11%, respectively). As well as, tomato peels contained the highest amount of crude fiber (37.36%) followed by purple carrot pomace and orange peels (11.93 and 10.73%, respectively). As for, the mineral content of raw materials, it could be concluded that, purple carrot pomace and tomato peels are considered as a good source of potassium and calcium (2340 and 1660 mg/100g, respectively, whereas, calcium is the predominant mineral in orange peels (1140 and 1030 mg/100g, respectively). For bioactive compounds and antioxidant activity in raw materials. The results show that orange peels and purple carrot pomace had the highest content of total phenolic (16.12 and 10.08 mg /g, respectively) and antioxidant activity (88.65 and 86.48 %, respectively). Meanwhile, tomato peels had the lowest content of total phenolic (3.75 mg/g), flavonoids content (0.97 mg/g) and antioxidant activity (38.31%).

• **Extraction of natural pigments**.

Anthocyanin pigment was extracted from the purple carrot by 4% citric acid, which is a good source of anthocyanin (130.54 mg / 100 g on dry weight basis). β- carotene was extracted from the orange peels by acetone, and the amount of β-carotene extracted was 14.15 mg / 100 g dry weight. Also, Lycopene was extracted from tomato peels with acetone and the extracted amount was 3.75 mg / 100 g on dry weight.

• **Identification of natural pigments by HPLC.**

Anthocyanin spectrometry and separation showed that there are two main anthocyanin extracted from purple carrot pomace, cyanidin 3-glucoside (62.27 µg/ml) and delphinidin (39.46 µg/ml). β-carotene, extracted from orange peels, was also identified and contained an important compound, β-carotene. Lycopene extracted from tomato peels has also been identified and spectral measurements and separation show that there are two major lycopene compounds, lycopene and β-carotene (2.28 and 1.80 μg/ml, respectively)

- **Study the factors affecting the stability of natural pigments.**
- **Stability of anthocyanin pigment extracted from purple carrot pomace.**

The effect of different pH values on the stability of the anthocyanin pigment using nine pH values (2, 3, 4, 5, 6, 7, 8, 9, 10) was studied. The results showed that the stability of the anthocyanin pigment was more stable at pH values (2 to 5), while the highest decrease occurred at pH 7. The effect of different temperature degrees (40°C, 60°C, 80°C, 100°C) at different time intervals (30, 60, 90, 120 min.) on the stability of the anthocyanin pigment was studied. The anthocyanin extract was more stable at 40 and 60 ° C for 30 to 120 minutes, while at 80 and 100 ° C for 30 to 120 minutes, the anthocyanin content decreased. It was observed that the rate of degradation of the anthocyanin pigment increased with the increase of the temperature of heating and the exposure period to these degrees, which leads to the faster deterioration of color during heating. The effect of light at different time intervals (1, 2, 3, 4, 5, 6 hours) on pigment stability and the light is a factor affecting anthocyanin pigment stability. The obtained results showed that anthocyanin decompose slowly in the dark recorded 5.13 % and degrade with high rate under lighting conditions recorded (7.05 %) for 6 hours, which accelerates the degradation of anthocyanin.

• Stability of β-carotene pigment extracted from orange peels.

The effect of different pH values (2, 3, 4, 5, 6, 7, 8, 9, 10) on the stability of β-carotene has been studied. The obtained results showed that the rate of degradation of the pigment increased with a decrease in the pH values. This indicates that the alkaline media pH 9 was highly effective in maintaining pigment stability. The effect of using different temperature degrees (30°C, 40°C, 50°C, 60°C, 70°C, 80°C, 90°C and 100°C) on the stability of the β-carotene pigment at different pH values (8, 10) has been studied. It was observed that the degradation of the pigment gradually increases with increasing temperature degree. The decrease in the rate of pigment degradation was even higher at higher pH values.

The effect of heat exposure time (30, 60, 90, 120 min.) at different pH values (8, 10) on the stability of β -carotene pigment was studied. It was observed that by increasing both the temperature and the exposure time, the pigment degradation was increased at the lower pH values. The effect of light at different time intervals (1, 2, 3, 4, 5, 6 hours) on pigment stability was studied. The results show that the pigment decomposes slowly in the dark reached to 6.25% and the degradation increases significantly under lighting conditions reached to 9.72% due to the effect of light on the acceleration of the pigment demolition.

• Stability of lycopene pigment extracted from tomato peels.

The effect of different pH values (2, 3, 4, 5, 6, 7, 8, 9, 10) on pigment stability was studied. The obtained results showed that lycopene was less stable in acid medium and more stable in alkaline medium. The effect of using different temperature degrees at (30°C, 40°C, 50°C, 60°C, 70°C, 80°C, 90°C, 100°C) on pigment stability under different pH values (8, 10). It was observed that the decrease in acidity increases the degradation of the pigment gradually with increasing temperature, and by studying the effect of heat exposure time (30, 60, 90, 120 min.) at different pH values (8, 10) on the stability of lycopene pigment.

It was observed that, when the pigment exposure time increased, there was an increase in the rate of degradation of lycopene at the lowest pH value and high temperature degree. The lowest degradation was recorded at low and medium temperature degrees and high pH values. The effect of light at different time intervals (1, 2, 3, 4, 5, 6 hours) on pigment stability was studied. It was concluded that lycopene slowly decomposes in the dark (5.64%) and strongly decomposes under light conditions (6.85%).

• Study the stability of the pigment β-carotene and lycopene using Rancimat.

The effect of crude β-carotene extract (100, 200, 300 ppm) on the oxidative stability of sunflower oil was studied. It was found that by adding different levels of pigment extracted from orange peels to sunflower oil and comparing its oxidative stability compared to using BHT. It was found that the crude extract of β-carotene acts as a first antioxidant when it was present in high concentrations. The effect of the addition of crude lycopene extract (100, 200, 300 ppm) on the oxidative stability of sunflower oil. The results indicated that the crude lycopene extract at high concentrations acts as a first antioxidant, while lower concentrations of lycopene extract acted as an antioxidant and helped stabilize sunflower oil. Also, different concentrations of crude lycopene had antioxidant activity compared BHT.

• **Sensory evaluation of natural colored products.**

Sensory evaluation of guava jam colored with natural anthocyanin pigment extract was evaluated in the following percentages (0%, 0.5%, 1.0%, and 1.5%). It was found that by adding the anthocyanin extract of 1.0% (the third treatment) scored the highest sensory evaluation of the jam and was favored by consumers. The addition of natural β-carotene to ice cream at 1.0% (4th treatment) was found to be widely accepted and favored by consumers compared with the artificial colored treatment and also the other treatments. As for, the sensory evaluation of beef burger stained with natural lycopene in the following percentages (0%, 0.5%, 1.0%, and 1.5%). In terms of color, taste and degree of overall acceptability compared with other treatments, as well as, added artificial color. Whereas, treatment (second treatment) without any addition was recorded to have lower scores in the sensory evaluation.

• **Color measurements for the products**.

The results showed that guava jam appeared in a distinctive bright red color due to the addition of anthocyanin. The simple change in the color of the guava jam produced by the use of the anthocyanin pigment indicates the suitability of these processes to produce high quality and palatable products. Also, there was a clear effect of adding β-carotene to the properties of ice cream color and giving a more yellow colored product than ice cream samples without adding the pigment, as well as, the use of lycopene pigment to produce meat burger led to a bright red color than the meat burger samples without Add lycopene pigment.

• **Effect of storage on the stability of natural pigments in jam, ice cream and burger.**

The addition of anthocyanin extract at room temperature and 4°C by 1% resulted in the production of guava jam, which was the most acceptable and recorded the highest sensory quality standards compared to other concentrations, followed by the treatment which the pigment was added by 0.5%. It was observed that the effect of storage on the color density of guava jam and the rate of low color density was higher in samples stored at room temperature compared to those stored at 4°C.

The effect of storage on the stability of β-carotene in ice cream at -18°C. A slight degradation of the pigment added was clearly observed during the ice-cream storage period for 21 days recorded

4.69% during storage period under freezing conditions. The effect of storage on the stability of lycopene in meat burger stored at -18°C. From the obtained results it was observed that during storage for 12 weeks for the meat burger samples added the lycopene pigment deterioration of the added pigment recorded 11.49% during storage under freezing conditions. The main cause of the degradation of natural lycopene in foods is the oxidation process.

Finally, it could be clearly concluded through this study, that, it is practicable, available, economical and hence successful to the utilization of some food processing wastes to produce some natural pigments and using of these pigments for coloring some food products instead of artificial colors. This would lead to produce, high nutritional value, as well as, healthy products.