KdG Research
University of Applied Sciences and Arts

Research project **Biocolor**: natural dyes from plant materials and agricultural by-products

Introduction

Color is an important criterion of attractiveness and acceptability of many products, such as textiles, cosmetics and food. While dyes were exclusively natural in the past, this changed in the 1850s when mauveine was the first synthetic dye to be produced. Due to high expectations concerning the performance of colorants, the majority of dye substances used in several industries nowadays have a synthetic origin. A disadvantage of the synthetic dyes is its potential to cause health problems and its harmful effects on the environment. Therefor, regulations for the use of colorants has become more strict during the last decades. Coupled with the ecological awareness of consumers, the development of high-performing natural dyes is in high demand.

In this context the Biocolor research project (2020-2022) was launched. In collaboration with its industrial and academic partners, the project examined the potential of plant materials and agricultural by-products as a source for high-performing colorants. Textiles, food and candles were chosen as case studies to apply the produced dyes. The agricultural residues and biomass that will be used for this project are principally available in Belgium and the Netherlands.

Food

This case study describes the complete cycle of the production of colored food products. Two types of food were chosen to be colored, namely plain yogurt and mayonnaise. Since food regulations complicate the use of unusual ingredients in food, the plant materials tested were already allowed in food products (table 1).

Table 1: List of plant materials and agricultural by-products used to color food.

Food type	Plant species	Scientific name	Plant part used	Color obtained
Mayonnaise	Yellow onion	*Allium cepa*	Peel	Orange/yellow
Mayonnaise	Red onion	*Allium cepa*	Peel	Pink
Yogurt	Radish	*Raphanus sativus*	Root skins	Pink
Yogurt	Common marigold	*Calendula officinalis*	Flower	Orange/brown

This report will present the following:

- Production of plant extracts
- Yogurt test
- Mayonnaise test

Production of plant extracts

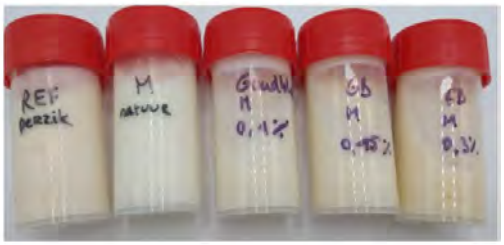
Marigold flowers and radish press cakes were supplied dried and ground by ILVO Food Pilot. The ground marigold flowers were supplied either with or without the green flowerheads included in the samples. Onion peels were milled as well to decrease particle size.

Solid liquid extraction (SLE) was used to extract the coloring substances from the plant materials. To do so, a 50 g L^{-1} solution was made of each dried material, using water as the extraction solvent. The solution was stirred at 90 °C during 60 minutes. Afterwards the solution was sieved to remove the raw material. The produced extracts could either be concentrated using a rotary evaporator, or dried to form a powder using a lyophilisator.

Yogurt test

Full and low fat yogurt were included for this test. 0,15-0,30-0,45% powdered radish extract was added to compare its color with commercial strawberry yogurt.

A commercial peach yogurt was compared with 0,10-0,15-0,30% powdered marigold extract added to the yogurt samples.



L*a*b*-color measurements were performed to monitor the stability of each yogurt sample. The powdered extracts overall performed well compared to the commercial reference and showed a good color stability during 7 days. Both plant materials gave a better color to the low fat yogurt.

A concentrated radish extract (225 g L^{-1}) was used to perform the same test. It was added at concentrations of 10-12-14% to low fat yogurt. Again, the color stability of all samples were monitored. No significant color changes were noted over a course of 14 days. However, the samples with the highest added concentrations of radish extract revealed an effect on the viscosity of the yogurt. These samples showed to be more liquid compared to the reference.

Mayonnaise test

Concentrated extracts of yellow and red onion were produced to test their capacity to color mayonnaise. Both extracts were added at concentrations of 6-12-20%.

After 7 days storage of all samples in the fridge, color stability of all samples was judged to be of good quality. Moreover, the 6% addition of onion extracts did not change the viscosity of the mayonnaise. 12 and 20% addition of yellow onion extracts did alter the viscosity and made the samples look more like salad dressing. However, this effect was not observed when the red onion extract was added, since this made the mayonnaise more firm. At last, only the 20% red onion sample showed the separation of a water layer on the surface of the sample.

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Evaluation of the case study

The use of plant materials and agricultural by-products for food coloring shows promising results. Current food regulations constrain the use of new ingredients in food products, since they require to be approved by 'novel food' EU legislation. Therefor this case study worked with approved foodstuffs. Overall, the 4 tested plant materials show good results in terms of color stability. Depending on the added quantities of extract, the viscosity of the food stuff can be affected. Attention should be given to the fact that all results presented in this report were obtained by performing experiments in a laboratory setting on a non-industrial scale. The performance of the extracts to color for example baked goods or drinks has not yet been examined. Another important feature to keep in mind is the unwanted taste or smell some plant materials can inflict on the food product.

Some restrictions concerning the use of plant materials were identified during the project:

- To obtain sufficient quantities of raw materials
- To obtain regular supply of raw materials, since some are only available during a limited time of the year.
- To obtain consistent color results, despite differences in the source of the same material

These limitations should be addressed before plant materials can be seen as a perfect alternative to replace currently used synthetic food colorants.

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In collaboration with Centexbel, Delphy, HoGent, Ilvo Foodpilot, Inagro and Masureel