Optimization of Carotene Pigment Production by Soxhlet Extraction from Waste Orange Peels

Kodal S. P.[1], Aksu Z.[1*]

[1]Department of Chemical Engineering,

Hacettepe University, 06532 Ankara, Turkey

[*]e-mail: zaksu@hacettepe.edu.tr

Abstract People expectations for and knowledge about the foods they consume rise as the society develops and becomes more conscious. How they collect their waste, make use of them for new products, what their economic values are, how healthy they are, their environmental value and so on are all important. Many substances like dietary fiber, antioxidants, pectin, fatty acids, and pigments. all of which are crucial for nutrition are present in fruit and vegetable wastes with these issues in mind the author of this study aims at. The production carotene pigment, a kind of natural flavonoid, from waste orange peels by Soxhlet extraction and hopes to use it as food additives. The production of carotene pigments from dried pulpy, dried pulpless and frozen pulpy waste orange peels were performed by forthlest quad Soxhlet extraction. The effects of type of peel, particle size, liquid/solid ratio, type of solvent and pre-treatment of the peel before extraction on the yield were investigated. In the pigment extraction from frozen pulpy peels with ethanol at 79^{o}C with the particles in the size range of 1.41-3.36 mm and at 40:1 liquid/solid ratio, the highest carotene pigment yield was found as 0.45% (4.5 mg carotene pigment/ g dry peel).

Keywords: *Waste orange peel, Carotene pigment, Optimization, Soxhlet extraction*

Introduction

People have become more conscious about the nutritional values of the foods they consume as they develop and learn more and does their expectations rise. As soon outcome of this tendency, the issues such as waste control and clean environment have become top interests of people and the attention and evaluation of the wastes released are at a level that cannot be ignored. The collection of wastes at their source and their use in the production of new products, their effect on human health, how organic the product are, what economic value they have or their environmental quality get full attention. Many substances such as dietary fiber, antioxidants, pectin, fatty acids, pigments which are all very important for nutrition exist in fruit and vegetable wastes. For human health antioxidants from fruit, and vegetables and beverages all play important role, like preventing cancer and cardiovascular diseases and also decreasing the incidence of other diseases (1.Oroian, M. and I. Escriche, 2015). Many fruit wastes such as grape leaves, apple, tomato and citrus peels are known to be rich in nutrients such as flavonoids, pigments, phenolic acids, polyolefins and anthocyanins (Moure, A., *et al*., 2001, Jayaprakasha, G.K., R.P. Singh, and K.K. Sakariah, 2001, K.J.Carson, J.L.C., M.P.Penfield, 2006). Using different methods, for both evaluation and inclusion in the food chain, these substances are extracted from wastes. According to the World Health Organization statistics as of 2012, 131 million tons of citrus fruit are produced are produced in the world and 52% of total production is oranges, at around 9 million hectares of land. Recent studies have proved that citrus fruits have important effects, especially on cardiovascular diseases and cancer, as mentioned before and also on circulation and strengthening the immune system. Carotenoids are important natural pigments, also a class of terpenoid pigments, commonly found in many plants and microorganism and are used as natural food colorants and preferred over synthetic pigments (Edge, R., D.J. McGarvey, and T.G. Truscott, (1997), Rock, C.L., 1997). When the chemical structures of carotenoids are examined, it is seen that they are soluble in oil. 8 isoprenoid units are arranged side by side to form a 40 carbon central structures. Due to their structural diversity these compounds play an important role in many biological activities. For plants that photosynthesize and need oxygen these compounds are again of vital importance (Macías-Sánchez, M.D., *et al*., 2010). In addition to their use as coloring agent in plants, carotenoids have also high vitamin A activity and are effective in reducing heart diseases and cancer risk and have antioxidant functions. For this reason, carotenoids have an important place among natural pigments (Rock, C.L., (1997), Chaudhry, Y.,2003). Various extraction techniques are applied to obtain bioactive compounds. Soxhlet extraction with the developing technology is made more suitable for automation, consuming less solvent and shorter extraction time (Sparr Eskilsson, C. and E. Björklund, (2000), Wan, H.B. and M.K. Wong, 1996).

As a result of research in this study, the production of orange pigment to be used in foods by using the extraction, obtained by means of Soxhlet extractor, abundant both in production and consumption has been targeted. Also determining the most favorable conditions of natural pigment production evaluating parameters such as solvent type, shell type, size analysis, time etc. has been aimed.

2. Materials and methods

Fresh orange peels are obtained from the municipal fruit juice extraction plant. Some of the shells are directly stored at -18 °C for freezing. Some of them are left to dry in open air in dark. Then the size reducing is done. Soxhlet extraction technique is used in experiments. Ethanol is the solvent for the extraction. The experimental parameters can be seen in the Table 1.

Since extraction is known to be a balancing process, extractions are continued until the point at which the formation process of the product is fixed, and quantity and content are determined by taking samples from each siphon. In the study, the Soxhlet extractor in which the extraction process is performed is shown in Figure 1.

Parameter	Worked Value
Particle size interval (mm)	<0.500 / 0.500-1.19 1.190-1.410 / 1.410-3.360
Pre-treatment	Swelling
Liquid/solid ratio (L/kg)	40:1 / 20:1 / 13.3:1 / 10:1
Type of the peel	Pulpy peel /Dried pulpy peel Frozen pulpy peel /Dried pulpless peel

Table 1. Parameters studied in extraction process

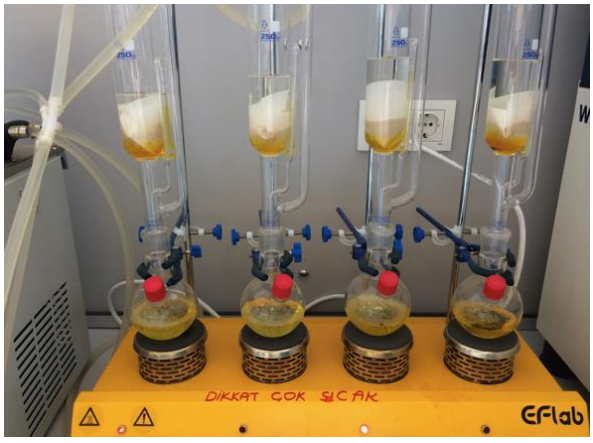

Figure 1. Soxhlet extractor used in experiments

The analysis of the caroten pigment is done by uv-visible spectrofotometry. And also it is planed to do FTIR and TGA analyzes of the product.

3. Conclusion

In this study, it has been aimed to obtain a substance which gives coloring and odor by extracting from orange peels, which is generally wasted in the world, and studies are still continuing.

Refererces

Chaudhry, Y., *Carotenoids-Natural Food Colors and Health Benefits.* Symposium 12. Interaction of Natural Colors with Other Ingredients. , 2003. **7**(19): p. 1-11.

Edge, R., D.J. McGarvey, and T.G. Truscott, *The carotenoids as anti-oxidants — a review.* Journal of Photochemistry and Photobiology B: Biology, 1997. **41**(3): p. 189-200.

Jayaprakasha, G.K., R.P. Singh, and K.K. Sakariah, *Antioxidant activity of grape seed (Vitis vinifera) extracts on peroxidation models in vitro.* Food Chemistry, 2001. **73**(3): p. 285-290.

K.J.Carson,J.L.C.,M.P.Penfield, *Unrefined, Dried Apple Pomace as a Potential Food Ingredient.* Journal of Food Science 08/2006. **59(6)**: p. 1213 - 1215.

Macías-Sánchez, M.D., *et al.*, *Supercritical fluid extraction of carotenoids from Scenedesmus almeriensis.* Food Chemistry, 2010. **123**(3): p. 928-935.

Moure, A., *et al.*, *Natural antioxidants from residual sources.* Food Chemistry, 2001. **72**(2): p. 145-171.

Oroian, M. and I. Escriche, *Antioxidants: Characterization, natural sources, extraction and analysis.* Food Research International, 2015. **74**: p. 10-36.

Rock, C.L., *Carotenoids: Biology and treatment.* Pharmacology & Therapeutics, 1997. **75**(3): p. 185-197.

Sparr Eskilsson, C. and E. Björklund, *Analytical-scale microwave-assisted extraction.* Journal of Chromatography A, 2000. **902**(1): p. 227-250.

Wan, H.B. and M.K. Wong, *Minimization of solvent consumption in pesticide residue analysis.* Journal of Chromatography A, 1996. **754**(1–2): p. 43-47.