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PRODUCTION OF A DIACYLGLYCEROL-ENRICHED SAFFLOWER OIL USING LIPASE-CATALYZED GLYCEROLYSIS: OPTIMIZATION BY RESPONSE SURFACE METHODOLOGY

Sayed Mohammad Sahafi[1*],
Sayed Amir Hossein Goli[1] and Mahdi Kadivar[1]
Isfahan University of Technology, Iran

Abstract

Purpose: This study aimed to develop a model for producing diacylglycerols (DAGs) in safflower oil. Oils with a high diacylglycerol (1,3-DAG) content have attracted considerable attention due to their favourable effects in preventing many diseases. There are valid scientific reports on the effects of diacylglycerol oil in preventing the accumulation of body fat and obesity, increased sensitivity of cells to insulin, reduced sodium concentration in the blood, LDL and cholesterol and blood pressure in people with atherosclerotic disease.

Design/methodology/approach: In this study, 1,3-DAG was synthesized from safflower oil using the glycerolysis reaction in a solvent-free system with lipozyme TL IM as a biocatalyst. A D-optimal design was used to model and optimize the reaction conditions. Evaluation of the resulting model enabled the determination of optimal reaction conditions for glycerolysis, aiming at a high DAG yield. The glycerolysis reaction was optimized with four factors of temperature, time, molar ratio of glycerol to oil and enzyme percentage.

Findings: The DAG content of the product was dependent on all parameters examined except reaction temperature. DAG formation increased with in-

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[1] Department of Food Science, College of Agriculture, Isfahan University of Technology, Isfahan, IRAN 84156-83111
[*] E-mail address: sm.sahafi@yahoo.com

creasing substrate ratio and decreasing enzyme load and reaction time. The highest DAG production was 52% (w/w, on the basis of total fat) and optimal conditions were found to be 0.75% enzyme, 5.3 g glycerol, a temperature of 46.9 °C and a reaction time of 4 h. In these conditions, after purification, DAG content increased to 53.84. The content of sn-1,3-DAG was higher than that of sn-1,2-DAG (70:30) under all reaction conditions.

Keywords: Safflower oil, Lipozyme TL IM, Glycerolysis, Diacylglycerol oil

Paper type: Research paper

INTRODUCTION

Fats and oils are essential ingredients and important components in our daily diet (Lo *et al.*, 2008). They are important sources of energy, essential fatty acids and fat-soluble vitamins, and impart excellent flavour, texture and palatability to the food (Wang *et al.*, 2009). However, studies have documented the health concerns associated with diets high in fats. A high intake of fats has been responsible for the high incidence of cardiovascular disease, hypertension, and obesity. Diacylglycerols (DAGs), are esters of glycerol with two fatty acids (FAs) which have two structural isomers, i.e., sn-1,2(2,3) DAG and sn-1,3 DAG. DAGs are the most widely used emulsifiers in food and pharmaceutical industries. These new healthy oils are naturally present as minor components in various edible oils and fats (Yang *et al.*, 2004), and are digested and metabolized in a different way, which significantly affects the body weight increase (Kristensen *et al.*, 2005a).

Recently, it has been reported that the use of DAG as a cooking oil has health benefits (Lo *et al.*, 2004). In early 1999, Kao introduced a novel application of diacylglycerol oil as a functional cooking oil to Japanese consumers. Researchers at Kao have found that DAG oil has metabolic characteristics that are different from triacylglycerol (TAG) oils (Lo *et al.*, 2008). DAG oil (which is 1,3-DAG) is the first and only oil clinically shown to be stored less as fat in the body compared to other edible oils. The energy value of DAG oil and TAG oil (with similar fatty acid composition) was virtually identical, that is 9.30 and 9.46 kcal/g, respectively. Moreover, no significant differences in absorption rates (96.3% in both cases) were observed. Therefore the beneficial characteristic of DAG oil is not due to a difference in energy value or absorption rate, but is attributable to the different metabolic mechanism