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Optimization of the production of structured lipid by enzymatic interesterification from coconut (*Cocos nucifera*) oil and sesame (*Sesamum indicum*) oil using Response Surface Methodology

Subajiny Sivakanthan[a], Anura Prasantha Jayasooriya[b], Terrence Madhujith[c,*]

[a] Department of Agricultural Chemistry, Faculty of Agriculture, University of Jaffna, Sri Lanka
[b] Department of Basic Veterinary Sciences, Faculty of Veterinary Medicine and Animal Science, University of Peradeniya, Sri Lanka
[c] Department of Food Science and Technology, Faculty of Agriculture, University of Peradeniya, Sri Lanka

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ABSTRACT

Blends of coconut (*Cocos nucifera*) oil and sesame (*Sesamum indicum*) oil were enzymatically interesterified using aqueous lipase derived from *Rhizomucor miehei* and the reaction conditions, namely, temperature (45–65 °C), time (16–48 h) and mass ratio of oils (CO:SO; 70:30–50:50) were optimized using Response Surface Methodology (three-factor, three-level central composite design). Degree of interesterification (DI), and the ratio of monounsaturated and polyunsaturated fatty acids (MUFA:PUFA) of triacylglycerols were used as response variables. The linear effects of all factors were significant for the DI while for MUFA:PUFA, the linear effect of oil ratio and interaction effect of time and oil ratio showed significant effects. The conditions, temperature; 57 °C, time; 16 h and weight ratio of oil (coconut oil:sesame oil); 50:50 were found to be the optimum. The R^2 value for DI and MUFA:PUFA ratio were 0.80 and 0.82, respectively. Models fitted for both DI and MUFA:PUFA ratio were significant with non-significant lack of fit. Produced structured lipid exhibited superior nutritional, physical and chemical properties than its raw counterparts. Therefore, the constructed models and data provide useful information to produce structured lipid from interesterification of coconut oil and sesame oil in up-scaled level. The produced novel lipid containing beneficial fatty acids from both oils could be used to produce healthy fat based products.

1. Introduction

Interesterification is the exchange of fatty acids within and among triacylglycerol (TAG) moieties leading to generation of structured lipids. These specialty lipids could be designed to contain the desired fatty acid composition having a multitude of applications as for medicinal and nutritional purposes and for the food industry (Reena, Reddy, & Lokesh, 2009). Interesterification can be performed either chemically or enzymatically. Of the two methods, enzymatic interesterification offers advantages over chemical interesterification such as mild processing conditions involved, preservation of fatty acids in *sn*-2 position when *sn*-1,3 specific lipase is used, thus preserving its natural benefits, less by-products and easy control of the process (Zhang, Smith, & Adler-Nissen, 2004). Enzymatic interesterification is gaining popularity as a green technology to produce modified lipids with improved nutritional and functional benefits and without *trans* fats.

Coconut (*Cocos nucifera*) is one of the major plantation crops cultivated in Sri Lanka over many decades and coconut oil (CO) is the widely used edible oil in the country accounting for approximately 94% of edible oil consumption by Sri Lankans (Annual Report, 2016). CO is composed of 92% of saturated fatty acids of which more than 50% are medium chain fatty acids (MCFAs) such as C8:0, C10:0 and C12:0. Intake of dietary saturated fatty acids has been welknown to be associated with increasing low-density lipoprotein (LDL) cholesterol, thus, associated with increasing the risk of cardiovascular diseases (Siri-Tarino, Sun, Frank, & Krauss, 2010). However, it is reported that different saturated fatty acids have varying effects on LDL cholesterol, HDL cholesterol, and the TC:HDL. Lauric acid (12:0) could raise LDL cholesterol higher compared to myristic (14:0) and palmitic (16:0) acids (Mensink, Zock, Kester, & Katan, 2003). Thus, replacing some of the saturated fatty acids (SFAs) such as lauric acid and LCFAs with nutritionally important fatty acids such as monounsaturated fatty acid (MUFA) and polyunsaturated fatty acids (PUFAs) is beneficial.

Since antiquity, sesame (*Sesamum indicum*) oil (SO) has been well

* Corresponding author. Postal address: Department of Food Science and Technology, Faculty of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka.
E-mail address: tmadhujith@pdn.ac.lk (T. Madhujith).

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