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Biochemical characterisation of the soluble proteins, protein isolates and hydrolysates from oil palm (*Elaeis guineensis*) kernel

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ABSTRACT

Oil palm kernel proteins have been less well characterised than other seed proteins. Hence, this study characterised the extractable proteins, protein isolate and hydrolysates of defatted oil palm kernel meal to provide information regarding the biochemical properties of oil palm kernel proteins affected by two harvest seasons (2010 and 2011). The defatted oil palm kernel meal and the protein isolate contained 54.8% and 75.6% protein, respectively. The polypeptide molecular mass ranges of the defatted oil palm kernel meal, the protein isolate and the protein hydrolysates were 19–50, 15–50 and 7–12 kDa, respectively. The alkali-soluble glutelin fraction (60%) was the major soluble portion of the oil palm kernel meal, followed by albumin (25%) and globulin (5.7%). The oil palm kernel protein isolate and hydrolysates showed significantly better amino acid profiles than the extractable soluble fractions, meeting all the essential amino acid requirements for infants, preschool children, adolescents and adults. Threonine was not detected in the defatted oil palm kernel meal nor in any of the extractable fractions, while serine was the least abundant detectable amino acid in the protein isolate and hydrolysates. Both the protein isolate and the hydrolysates were rich in cysteine, methionine, valine and lysine. Globulin and albumin were most sensitive to seasonal variations in amino acid composition and protein content. In conclusion, oil palm kernel protein isolate and hydrolysates generated from the defatted oil palm kernel meal can potentially be utilised in the food and health-based industries due to their good amino acid compositions and high protein contents.

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1. Introduction

Plant proteins play a significant role in human nutrition, particularly in developing countries, where the average protein intake is less than that required (Evangelista, Wu, & Hojilla-Evangelista, 2006). Because of inadequate supplies of quality protein, there has been a constant search for unconventional legumes or plants as new protein sources for use as both functional food ingredients and nutritional supplements (Semiu, Folake, Hans-Peter, Andrea, & Samuel, 2009). For plant proteins to be successfully applied in food products, they should possess several desirable characteristics, such as functional properties and an adequate content of essential amino acids (Semiu et al., 2009). The proteins that are utilised in the food industry are from various sources, such as animal (e.g., gelatin), vegetable (e.g., soya, peanut and cashew proteins), and animal-derivatives (e.g., milk proteins). With the increase in protein requirements, new sources have been developed, such as cashew nut protein concentrates and isolates (Semiu et al., 2009) and milkweed seed isolates (Mila, Roque, & Wuc, 2009). Recently, it has become popular to obtain proteins with both ideal functionality and bioactivity, such as rapeseed protein isolate, which exhibits antioxidant activity (Semiu et al., 2009).

The oil palm industry is one of the main agro-based industries in Malaysia and Indonesia, contributing to more than 80% of the world's total palm oil production and exports (Ofori-Boateng & Lee, 2013). The oil palm is a unique crop, producing two oils from its fruit – palm oil from the mesocarp and palm kernel oil from the kernel. One hectare of an oil palm plantation produces a huge amount of biomass per year as waste, comprising empty fruit bunches, palm kernel shells, oil palm trunks, oil palm fronds and palm pressed fibre (Ofori-Boateng & Lee, 2013). This waste has raised considerable concern about the environmental problems it might cause. For example, one hectare of an oil palm plantation yields approximately 500 kg of palm kernel cake, the by-product from the extraction of palm kernel oil (Ofori-Boateng & Lee, 2013). Malaysia exported 2.4 million tonnes of palm kernel cake in 2010, contributing to the export revenue earned (Ofori-Boateng & Lee, 2013). There is 12–16% crude protein (dry basis) in oil palm kernels (Zahari & Alimon, 2003). Although the content of protein is not high in oil palm kernels, the amount of oil palm kernels available in Malaysia is huge. Moreover, oil palm (*Elaeis guineensis*) kernel proteins could be an interesting raw material for the preparation of protein isolates and hydrolysates possessing bioactivities.

However, there is little information on the compositional properties of oil palm kernel protein as well as a dearth of information on the food applications and potential uses of oil palm kernels. These aspects should be examined to identify other possible value-added uses for human nutrition, in addition to minimising the cost of waste management for the palm oil industry. These efforts are aimed at effective utilisation of inexpensive proteins for nutritional and functional purposes related to their health-promoting properties (WHO, 2007). The determination of amino acid profiles is essential to ascertaining nutritional quality with respect to the ratio of essential amino acids to total amino acids in the samples studied (WHO, 2007).

The present study was first conducted to determine the biochemical properties of the soluble proteins, protein isolates and hydrolysates extracted from the kernel of the oil palm fruit. The polypeptide molecular weights and the soluble classes of the major extractable protein fractions as well as their amino acid compositions were characterised. To study any potential seasonal differences affecting the protein compositions, samples from two different harvest years (2010 and 2011) were analysed because few data are currently available concerning the effect of growing season on the protein composition of oil palm kernel. We also describe the generation of an extensive oil palm kernel protein hydrolysate using oil palm kernel protein isolate from defatted meal as the starting material.

2. Materials and methods

2.1. Materials

Mature oil palm fruits were obtained from an oil palm plantation from Bagan Datok, Perak, Malaysia during two growing seasons, September 2010 and 2011, to investigate seasonal variability. The harvest included only oil palm fruits that were fully yellowish-red coloured but not overripe to avoid loss of turgidity. The fruits were collected from the same tree from the same beds of the same plantation before being immersed in distilled water for three days to soften the hard mesocarp. The seeds were cleaned by careful screening and aspiration. The shell of the seed was removed by crashing the outer layer of the kernel bearing the seeds. The peeled kernels were homogenised using a commercial food blender after removing the testae and rediculae and then stored at −20 °C before further analysis. We produced the defatted oil palm kernel meal in the laboratory ourselves because industrial preparation on a large scale may cause extensive degradation of the functional components desired.

2.2. Sample preparation

Ground oil palm kernels were defatted at room temperature (24 °C) for six hours using n-hexane. The defatted samples were air-dried in a fume hood overnight and then stored in screw-capped containers at −20 °C until use. Polyphenols were removed according to a method by Amin, Jinap, Jamilah, Harikrisna, and Biehl (2002). After removing the polyphenols, the residual water was removed with 100% cold acetone. The resulting polyphenol-free whitish powder was stored at −20 °C until further analysis. The efficiency of polyphenol extraction was determined by a qualitative test. For the qualitative test, a small portion of the powder was heated with 2 ml of 5 M HC1 for a few seconds (the appearance of a red colour indicates the presence of residual polyphenols).

2.3. Fractionation of oil palm kernel proteins using an Osborne-type procedure

The fractionation of the oil palm kernel soluble proteins was performed according to the method by Marcone, Kakuda,