Fat Migration of Lauric Hard-Butter and Non-Lauric Fat Used as Based Filling Centre in Dark Chocolate at Different Storage Temperatures

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Introduction
Oils and fats are used in a variety of confectionery products, contributing to flavour, texture, eye appeal, aroma, mouth feel, and significantly dictate the overall quality of the eating experience for the confectionery products. At the same time, it also influences the production activities, shelf life and storage condition requirements of the product. Therefore, fats or oils are the key to successful confections. The application of vegetable fats such as lauric hard butter or non-lauric fat in composite chocolate products, either to substitute cocoa butter with cheaper economic fat fillers or to obtain specific textural or flavour properties of confectionery products. However, these products have the potential to be affected by lipid migration especially if they are subjected to unfavourable storage temperatures, 25-32°C. This temperature range is common in Malaysia, ASEAN and Middle East Countries; the last two are the main importers of Malaysia Chocolates. When a confectionery product comprises of two different fat-containing components (Laurie or non-Laurie fats in filling and cocoa butter in chocolate coating) adjacent to each other, the former fats, which are relatively more liquid than cocoa butter at particular temperature, tend to migrate to the coating. As the consequence, the coating becomes soft as parallel with the hardening of filling resulting in the loss of perceived differences between the coating and the filling. Softening of the coating is due to the dilution of liquid glycerides and in some cases, it softens further because the filling fat is 'incompatible' with cocoa butter; as a result it forms eutectics. The two dissimilar materials could interact in such a way that the melting point of the blend is lower than the melting points of the individual components. Furthermore, migration may promote the formation of a surface "fat bloom" which gives a white/ grey appearance to the product as the result of recrystallisation. These physical deleterious could jeopardise the total performance of the end product specifically the commercial value and storage quality of the product. Therefore, the objective of the current study were to evaluate the effect of different storage temperatures on Laurie hard butter (palm kernel steering) and non-Laurie fat (palm mid-fraction) based filling fats in dark chocolate on fat migration; and to study the polymorphism changes of cocoa butter crystals due to palm kernel steering and palm mid-fraction migration.

Materials and Methods
For the production of dark chocolate coating, natural cocoa liquor and prime pressed cocoa butter were acquired from KL-Kepang Cocoa Products Sdn Bhd. (Port Klang, Selangor). Lecithin was obtained from Damah Trading Sdn. Bhd. (Cheras, Kuala Lumpur) whereas vanillin was imported from the New Perfumery Work (Shanghai, China). Sugar, salt and skim milk powder were procured from the retail supermarkets. On the other hand, palm mid-fraction and palm kernel stearin which was used as the filling fats were kindly donated by Socteck Sdn. Bhd. (Pasar Gudang, Johore). Carrageenan was imported from the local supermarkets. The other palm mid-fraction and palm kernel stearin were procured from the retail supermarkets. The other palm mid-fraction and palm kernel stearin was used as the filling fats were kindly donated by Socteck Sdn. Bhd. (Pasar Gudang, Johore). Carrageenan was reserved weekly interval to monitor the extent and effect of fat migration. Physical properties were encompassing of texture analysis, solid fat content and bloom test. Whereas, total fat content, triacylglycerol and fatty acid composition were performed in chemical analysis. Sensory evaluation for acceptability test was carried out by 30 panelists to attain the organoleptic properties of the filled chocolates in terms of texture, colour, flavour and overall acceptability after the two months of storage.

Results and Discussion
The effect of storage temperatures (18 and 30°C) on physicochemical properties of dark chocolates with palm kernel stearin and palm mid-fraction based desiccated coconut filling were carried out for the storage of eight weeks. The results on total fat content showed that the liquid lipids migrated...
Storage at 30°C with one induction cycle and four induction cycles respectively, but no bloom was occurred at 18°C. Chocolate with palm kernel steering was more resistant to bloom at the higher temperature because it suffered less eutectic effect than palm mid-fraction. Although both palm kernel steering and coconut oil are Laurie oils, palm mid-fraction with coconut oil suffered greater eutectic effect due to their lesser compatibility of triacylglycerols with each other and those from cocoa butter. The migration of palm mid-fraction with coconut oil into cocoa butter made the oil more liquid and more prone to bloom formation. Storage at 30°C produced substantially softer chocolates than storage at 18°C due to the difference in solid fat contents at the two temperatures. At 18°C, the filling fats were hard, and fat migration was minimal but at 30°C, the coconut oil and palm kernel steering triacylglycerols in the filling were liquefied and migrated to the surface where, being incompatible with cocoa butter disturbed its crystallisation, melted and softened it. The palm kernel steering and coconut oil being incompatible with cocoa butter formed a eutectic mixture which lowering the solid fat content of cocoa butter. Research found that mixing cocoa butter and cocoa butter extenders (CBE) with hydrogenated and fractionated palm kernel olein caused significant softening of chocolate due to the eutectic incompatibility between them which increased the liquid phase. As the counterpart, chocolate with palm mid-fraction stored at 30°C was very soft and greasy due to the fact that the palm mid fraction and coconut oil mixture was completely melted, allowing considerable migration of the filling fats to the surface. Palm mid-fraction and coconut oil, which had more different fatty acid compositions, experienced a greater eutectic effect. In general, the more dissimilar the fatty acid composition of two (or more) blended fats is, the greater the melting point depression and the softer the blend. The hardness of chocolate coating for palm kernel stearin and palm mid-fraction desiccated coconut filling were decreased significantly (p<0.05) from 3.49 to 2.77 kg/force and 1.89 kg/force respectively after storage of eight weeks at 18°C. The results of sensory evaluation shown that there were significant difference (p<.05) between the chocolates because of their storage temperatures. The panel preferred both of the chocolates stored at 18°C to those stored at 30°C.

Conclusions

Storage of dark chocolate with palm kernel stearin and palm mid-fraction based desiccated coconut fillings at low temperature (18°C) could inhibit the physicochemical changes in triacylglycerol composition (surface and core), penetration, solid fat content and bloom formation. Conversely, migration occurred more rapidly with maximum changes in the chocolate hardness, chemical composition and bloom formation. Sensory evaluation indicated that chocolates stored at 18°C were more preferable than 30°C in terms of sensory attributes of texture, colour, flavour and overall acceptability. It could be concluded that fat migration results in the changes of fatty acid and triacylglycerol composition, hardness, solid fat content leading to bloom formation. Therefore, storage at 18°C could prolong the shelf life of dark chocolates with palm kernel stearin and palm mid-fraction based desiccated coconut filling.

Benefits from the study

Ability to optimise the usage of cocoa butter replacers (equivalent, lauric and non-lauric substitutes) in filling formulation and process handling especially storage condition in order to boost up the quality and market value of the local filled chocolates. It is the potential benefit to chocolate manufacturers, especially fat producers and palm oil industry. Moreover, it could gain the recognition from prominent researchers in this field. The cocoa and chocolate group at FSMB has been internationally recognised for its contribution to chocolate research exclusively in fat migration. Invitation to present oral paper in prominent conference and seminar in foreign universities and research institutes has been happening for the past years and future. The cocoa/chocolate laboratories at FSMB also have attracted research officers and executives from Malaysian Cocoa Board and Indonesian Cocoa and Coffee Research Institute as cocoa or chocolate industries to carry out post-graduate study and training.

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Literature cited in the text
None.

Project Publications in Refereed Journals
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Project Publications in Conference Proceedings

Graduate Research