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 various 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[1]. At the same time, it also influences the production activities, shelf life and storage condition requirements of the products[2]. 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[3]. This temperature range is common in Malaysia, ASEAN and Middle East Countries; the last two are the main importers of Malaysia Chocolates[4]. 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 soften paralleled 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 glycosides but 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 recrystalisation[5]. These physical deleterious could jeopardise the total performance of the end product specifically the commercial value and storage quality of the product. Therefore, the objectives 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-Kepong 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* nc which was used as the filling fats were kindly donated by Socteck Sdn. Bhd. (Pasir Gudang, Johore),Cargrill Specialty Oils & Fats Sdn. Bhd. (Port Klang, Selangor). Desiccated coconut, skim milk powder and icing sugar were purchased from the local supermarkets. Chemical reagents, petroleum ether (BDH) and sodium methoxide (Merck) were of the analytical grade. Methanol (BDH), *acetone* (Fisher), *acetonitril* (Fisher), *triacylglycerol* standards (Sigma) e.g. 1,3 *dipalmitoyl-2-oleoyglycerol* (POP), 1-*palmitoyl-2-oleoyl-3-stearoyl* (POS), 1,3-*distearoyl-2-oleoyl-glycerol* (SOS), *triluarin* (LLL) and fatty acid methyl ester standards (Sigma) e.g. *lauric, myristic, palmitic, oleic, stearic, linoleic, linolenic methyl esters* were of HPLC grade. Dark chocolate comprises of chocolate liquor (42.0%), pulverized sugar (41.6%), cocoa butter (8.4%), skimmed milk powder (8.0%) and lecithin (0.4%) was prepared by mixing, refining (25-30 µm), and coaching (62-65°C for 16 hours). Blending of icing sugar (55%), palm kernel steering or palm mid-fraction (30%) and desiccated coconut (15%) was involved in the production of cream filling. The fat migration was stimulated in real product by using layer of cream filling and dark chocolates approximately 90 g each in a plastic container (10 x 5 x 5 cm length x width x height, respectively). All samples were stored for 2 months at 18 and 30°C respectively. Physicochemical properties were evaluated 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 term 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 until a pseudo-steady distribution of liquid *triacylglycerol* was reached at week-6 and 5 (18°C), and reaching faster after week-3 and 2 at storage temperature of 30°C in palm kernel *stearin* and palm mid-fraction based desiccated coconut filled chocolates respectively. The lipids in palm mid-fraction are more liquid than those from cocoa butter at room temperature; therefore, they tend to migrate more easily[5]. Moreover, as the liquid fat content (LFC) is temperature dependant, the storage temperature has a great effect on the diffusion constant and migration speed of the lipids[6]. The change of the fatty acids composition in chocolate filled with palm kernel *stearin* was minimal at 18°C compared to that stored at 30°C. Generally, C12:0 and C14:0 was increased with parallel decreased of C16:0, C18:0 and C18:1. In palm mid-fraction filled chocolate, the coating had increased of C12:0, C14:0 and C16:0 with lower of C18:0. The composition of C16:0 increased as it was the main fatty acid of palm mid-fraction and C12:0 and C14:0 promoted its migration. As stated[7], unsaturated acids (*oleic* and *linoliec*) and the shorter chain C12:0 and C14:0 migrate more than the saturated and longer chain ones (*palmitic* and *stearic* acids), but the former also promote the migration of the latter. The changes of fatty acid composition in the coating of palm kernel *stearin* based filling have resulted in increase of C36, C38 and C50, C52 and C54 decreased which was much smaller at 18°C than at 30°C. The results were in accordance with the study of the migration for palm kernel olein in chocolate stored at 20°C and 28°C[8]. The change in *triacylglycerol* composition in the coating of palm mid-fraction from migration was negligible even after eight weeks. However, there was more *triacylglycerol* migration at 30°C because of the more liquid fat from both the higher temperature and incompatibility between coconut oil and palm mid-fraction, and therefore a greater change in the *triacylglycerol* composition with increase of C36 while C52 and C54 decreased. This was corresponding with the study which had proved that liquid *triacylglycerol* migration was slow at 19°C and adversely much faster at 28 °C[9]. Fat bloom was observed in palm kernel steering and palm mid-fraction filled chocolate after 4 weeks' and 1 week 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 less 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[10]. 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[11]. 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 term 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 manufactures, especially fat producers and palm oil industry. Moreover, it could gain the recognition from prominent researcher 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 and cocoa or chocolate industries to carry out post-graduate study and training.

Literature cited in the text

None.

Project Publications in Refereed Journals

Ali, A., Jinap, S, Che Man, Y.B., Suria, A.M. 2000. Chemical and physical characteristics of dark chocolate as affected by migration of lauric filling fat at different storage temperatures. Accepted for publication at *International Journal of Food Science and Technology.*

Ali, A., Jinap, S., Che Man, Y.B., Suria, A.M. 2001. Effect of storage temperature on texture, polymorphic sructure, bloom formation and sensory attributes of filled dark chocolate. *Food Chemistry.* 72: 491-497.

Ali, A., Jinap. S., Che Man, Y.B., Suria, A.M. 2001. Characterization and Fat Migration of palm kernel stearin as affected by addition of desiccated coconut used as base filling center in dark chocolate. *International Journal of Food Science and Nutrition.* 52: 251-261.

Bigalli,G.L. 1988. Practical aspects of the eutectic effect on confectionery fats and their mixtures. *Manuf. Confect.* 68(5): 65-80.

Dimick, P.S. and Manning, D.M. 1987. Thermal and compositional properties of cocoa butter during static crystallization. *J. Am. Oil. Chem. Soc.* 64: 1663-1669.

Guiheneuf, T.M, Cousen, P., Wille, H.J. and Hall, L.D. 1997. Visuallisation of liquid triacylglycerol migration in chocolate by magnetic resonance imaging. *J. Sic. Food. Agric.* 73: 265-273.

Herzing, A.G. 1989. Eutectic effects of fats. *Manuf. Confect.* 69(10): 83-87.

Jinap, S., Ali, A., Che Man, Y.B., Suria, A.M. 2000. Use of palm mid-fraction in dark chocolate as base filling centre at different storage temperatures. *International Journal of Food Sciences and Nutrition.* 51: 489-499.

Malaysian Cocoa Board. 1999. *Malaysian Cocoa Monitor.* 8(2): 44-46.

Tabouret, T. 1987. Technical note: detection of fat migration in confectionery product. *Int. J. Food Sci. Technol.* 22: 163-167.

Talbot, G. 1990. Fat migration in biscuits and confectionery systems. *Confect. Prod.* 56(4): 265-266, 268-270, 272.

Talbot, G. 1996. The 'washer test"- a method for monitoring fat migration. *Manuf. Confect.* 76: 87-90.

Wainwright, R.E. 2000. Oils and Fats for Confections. *Manuf. Confect.* 80(10): 65-76.

Wootton, M., Weeden, D. and Munk, N. 1970. Mechanism of fat migration in chocolate enrobed goods. *Chem. Ind.* 32(8): 1052-1053.

Ziegleder, G. 1997. Fat migration and bloom. *Manuf. Confec.* 77(2): 43-44.

Project Publications in Conference Proceedings

Ali, A., Jinap, S., Che Man, Y.B., Suria, A.M. 1998. Physical and chemical properties of dark chocolate filled with refine palm olein. In: Proceedings of Malaysian International Cocoa Conference.

Ali, A., Jinap, S., Che Man, Y.B., Suria, A.M. 1999. Effect of desiccated coconut based filling center on mechanism of fat migration in dark chocolate. In: Proceedings of Porim International Congress.

Ali, A., Jinap, S., Che Man, Y.B., Suria, A.M. 2000. Effect of storage temperature on the rate of palm kernel stearin migration used as base filling center in dark chocolate. In: Proceedings of Oil and Fat International Congress.

Ali, A., Jinap, S., Che Man, Y.B., Suria, A.M. 2000. Effect of fat migration of meltaway-centre on the thermal behaviour and bloom formation in dark chocolate. In: Proceedings of International Cocoa Conference.

Ali, A., Jinap, S., Che Man, Y.B., Suria, A.M. 2001. Chemical, physical characteristics and sensory attributes of dark chocolate filled with desiccated coconut and palm mid-fraction or palm kernel stearin. In: Proceedings of 92th American Oil Chemists' Society Meeting.

Graduate Research

Abdelrahim Abdelbagi Ali. 2001. Food Chemistry & Biochemistry. [Ph.D]. Universiti Putra Malaysia.

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