STRUCTURAL STABILITY ANALYSIS OF SOLID FATS WITH HIGH AMOUNT OF LIQUID OIL

SIVARUBY KANAGARATNAM

771

The ability of fat crystals to bind and hold a certain amount of liquid oil within their crystal matrix is dependent on triacylglycerol composition (Chawla and deMan, 1990; Taylor, 1976), thermal properties (deMan *et al.*, 1995), and interaction of the fat crystals in the developed crystal network (Johansson and Bergenstayhl, 1995) of the fat blends. Fat blends of margarines, spreads and shortening are texturised to enhance entrapment of liquid within the crystals matrix, effectively immobilising the liquid oil within the fat crystal structure (Miskandar *et al.*, 2005; Heertje, 1993). This physicochemical property of fat crystals is defined as the oil-binding capacity. Bound oil represents the liquid oil that cannot be separated from the fat crystal. Under centrifugal force, fat blends with sufficient solid fats and strong crystal network will remain intact without experiencing separation or release of oil. In fat blends with insufficient solid fat, the weak crystal network will collapse and release the trapped oil when centrifuged. The level of liquid oil bound to fat crystals can play an important role in determining the stability and the performance of the fat blends in the desired application (Sivaruby *et al.*, 2013).

TECHNOLOGY

The strength of the crystal network in terms of the bonding of solid-liquid phase in the fat blends was determined by the LUMifuge Stability Analyser. The oil-binding capacity of fat crystals will be of great guidance in ascertaining the compliance of the blends to the desired firmness in margarines, spreads and shortening (Jahaniaval *et al.*, 2002). The stability analyser is able to effectively quantify the amount of oil released from the crystal matrix under centrifugal stress (Sivaruby *et al.*, 2013).

METHOD

The method to determine structural stability of solid fats with high amount of liquid oils was established by using a LUMifuge Stability Analyser. The phase separation analysis is performed using LUMifuge Model LF111 LUM (LUM Ltd., Berlin, Germany). This method provides a simple and reliable way to quantify the amount of liquid oil released by centrifugal force. The Stability Analyser applies centrifugal force with an in-built near infrared (NIR) detector to measure the amount of free oil released from the fat.

Samples are extracted at random positions from the central region of the bulk samples using a stainless steel piston to obtain an intact sample. The stainless steel piston is specially designed to slide into the centrifuge cell and facilitate the intact placement of samples into the cells. The samples are unloaded carefully into the cell to prevent any air space in it (Miskandar *et al.*, 2002). The loaded cells will be placed horizontally in the centrifuge. The centrifugal analysis will be determined according to the requirement of the samples to be evaluated. This system measures near infrared (NIR) transmission profiles continuously during centrifugation resulting in 255 measurements. The flow of detection is shown in *Figure 1*. LUMifuge's® software, SEPView 5.1, calculated the integral of every transmission curve over a chosen length (the sample length). Graphical representation of transmission as a function of position presents the transmission profile. Zones of concentrated fats will scatter and absorb light; hence, transmission will be lower. In contrast, clear liquid will raise the transmission levels. The integral of transmission over the sample length will be used to calculate the percentage of oil released (Sivaruby *et al.*, 2013; Klein *et al.*, 2010; Libster *et al.*, 2009; Kuentz and Röthlisberger, 2003).

Figure 2 shows the results of a study determining the dosage of binding agent required to produce a stable product. The dosage of binding agent used was A with 2%, B with 4% and C with 6%. The transmission profiles will assist in determining the dosage required. The transmission profile shows that Formulation A is unstable with large amount of oil released, Formulation B is partially unstable with partial oil released and Formulation C is the most stable with no oil released.
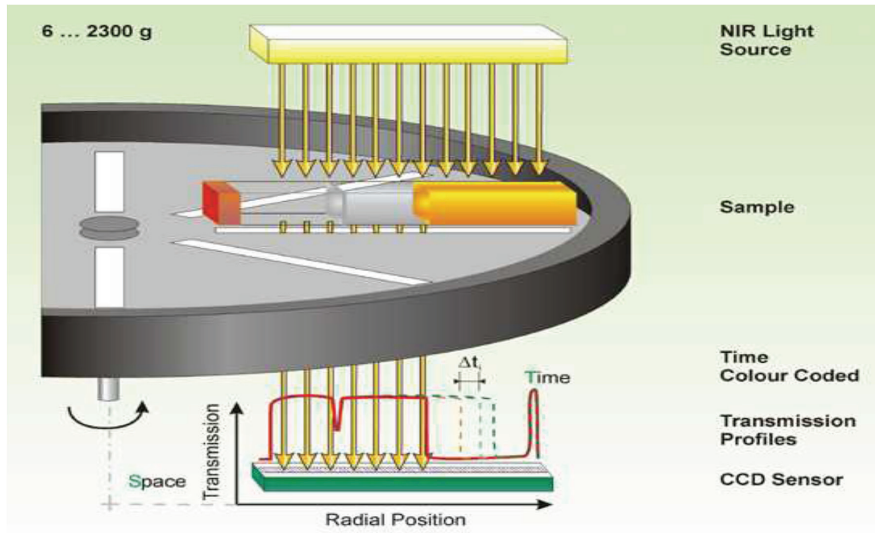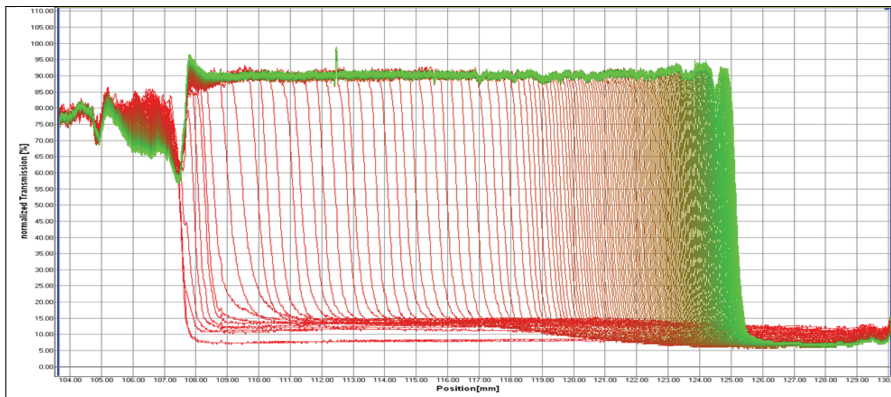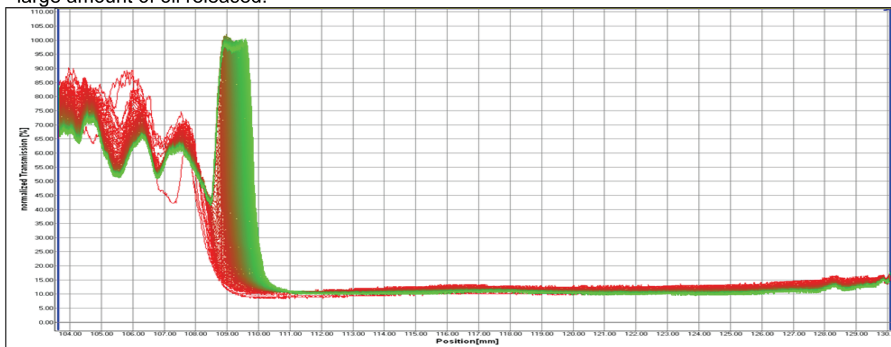
Figure 1. Schematic illustration of LUMifuge Stability Analyser's for determination of NIR transmission profile.

Transmission profile of Formulation A with 2% binding agent indicates unstable formulation with large amount of oil released.

Transmission profile of Formulation B with 4% binding agent indicates partially unstable formulation with partial oil released.
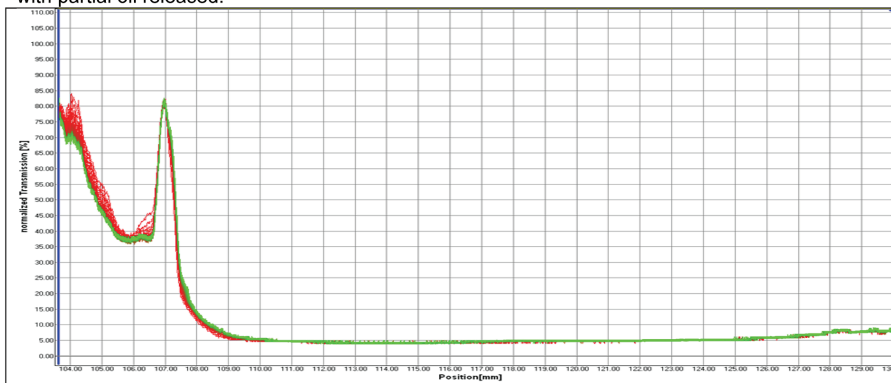
Transmission profile of Formulation C with 6% binding agent indicates stable formulation without oil released.

Figure 2. Stability Analyser transmission profiles indicating Formulation A very unstable, B partially unstable and C stable.

NOVELTY

Rapid and simple method to analyse the structural stability of solid fat foods with 80% and above liquid oils within the fat crystal matrix.

BENEFITS

- Rapid and simple method to determine stability of blends.
- Determines the strength of the crystal matrix that will retain the liquid oils within the crystal structure.
- Assists in the development of fat food formulations.
- Assists in eliminating oil out problem of fats based food products such as spreads, margarines, shortening and cooking fats.

SERVICE OFFERED

Stability evaluation of fat blend with high amount of liquid oil. (The minimum amount of sample required is 50 ml).

COST OF SERVICE

The indicative price of service is RM 150* per sample.
*subject to change

REFERENCES

CHAWLA, P and DEMAN, J M (1990). Measurement of the size distribution of fat crystals using a laser particle counter. *Journal of the American Oil Chemists' Society*, 67: 329-332.

DEMAN, L; DEMAN, J M and BLACKMAN, B B (1995). Effect of tempering on the texture and polymorphic behaviour of margarine fats. *Fat Sci. Technol.*, 97: 55-60.

HEERTJE, I (1993). Microstructural studies in fat research. *Food Structure, 12*: 77-94.

JAHANIAVAL, F; KAKUDA, Y and ABRAHAM, V (2002). Oil-binding capacity of plastic fats: Effects of intermediate melting point TAG. *Journal of the American Oil Chemists' Society*, 79: 389-394.

JOHANSSON, D and BERGENSTAYHL, B (1995). Sintering of fat crystal networks in oil during post-crystallization processes. *Journal of the American Oil Chemists' Society*, 72: 911-920.

KLEIN, M; ASERIN, A; SVITOV, I and GARTI, N (2010). Enhanced stabilization of cloudy emulsions with gum Arabic and whey protein isolate. *Colloids and Surfaces B: Biointerfaces*, 77: 75-81.

KUENTZ, M and RÖTHLISBERGER, D (2003). Rapid assessment of sedimentation stability in dispersions using near infrared transmission measurements during centrifugation and oscillatory rheology. *European Journal of Pharmaceutics and Biopharmaceutics, 56*: 355-361.

LIBSTER, D; ASERIN, A; YARIV, D; SHOHAM, G and GARTI, N (2009). Soft matter dispersions with ordered inner structures, stabilized by ethoxylated phytosterols. C*olloids and Surfaces B: Biointerfaces, 74*: 202-215.

MISKANDAR, M S; CHE MAN, Y B; YUSOFF, M S A and ABDUL RAHMAN, R (2002). Effect of emulsion temperature on physical properties of palm oil-based margarine. *Journal of the American Oil Chemists' Society*, 79: 1163-1168.

MISKANDAR, M S; MAN, Y C; YUSOFF, M S A and RAHMAN, R A (2005). Quality of margarine: Fats selection and processing parameters. *Asia Pacific Journal of Clinical Nutrition*, 14: 387-395.

SIVARUBY, K; ENAMUL HOQUE, M; MISKANDAR, M S and SPOWAGE, A (2013). Investigating the effect of deforming temperature on the oil-binding capacity of palm oil based shortening. *Journal of Food Engineering*, 118: 90-99.

TAYLOR, A M (1976). The crystallisation and dry fractionation of Malaysian palm oil. *Oleagineux, 31*: 73-79.

For more information, kindly contact:

Head of Corporate Implementation
and Consultancy Unit, MPOB
6, Persiaran Institusi,
Bandar Baru Bangi,
43000 Kajang, Selangor, Malaysia
Tel: 03-8769 4574
Fax: 03-8926 1337
E-mail: tot@mpob.gov.my
www.mpob.gov.my