CHOCOLATE SPREAD WITH TOCOTRIENOLS

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MPOB INFORMATION SERIES • ISSN 1511-7871 • JUNE 2015 MPOB TT No. 584

Lipid oxidation is a major cause of quality deterioration in fat-containing food products. The oxidised fat can cause changes in quality characteristics of food, such as taste, texture and shelf-life, which leads to undesirable off-flavours. In order to avoid deterioration, chemical-based antioxidants, such as butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT) and tert-butylhydroquinone (TBHQ), are commonly used. Antioxidants are compound that inhibit the oxidative process and delay lipid oxidation. Concerns about the safety of synthetic antioxidant have lead to more research on natural sources of antioxidants (Shahidi and Ying, 2004). Some natural antioxidants have been found effective against auto-oxidation and these include carotenoids, citric acid, ascorbic acid and vitamin E among others (Carelli *et al*., 2005).

Vitamin E is a natural fat-soluble compound which contains tocopherols and tocotrienols. Tocotrienol rich fractions (TRF) are available in the market at 50% and 70% concentrations. TRF is more potent as antioxidants compared to tocopherols (Choo *et al*., 1997). Its antioxidant activity in stabilising oil and fat was proven to prolong the shelf-life of the product (Hazura and Choo, 1997).

Chocolate spread is an oil-based emulsion. The product contains 32% - 38% fat based on palm oil fractions. It is prone to lipid auto-oxidation that develops during storage. In this study, palm tocotrienols were incorporated into chocolate spread to increase its shelf-life. The selected dosage of tocotrienols was able to deliver comparative oxidative stability as seen from the data of peroxide value (PV) and oxidative stability analysis. Besides that, tocotrienols contributed to a highly nutritious spread by retaining the vitamin E content even when stored for six months. Therefore the use of TRF can provide additional vitamin E for those with inadequate vitamin E intake. The product can be labelled as functional chocolate spread (*Figure 1*). The functional foods are generally those foods which are intended to be consumed as part of the normal diet and contained biologically active components which offer the potential of health or reduced risk of disease. This definition is accepted worldwide as there are no legal definitions of functional foods in most countries including Malaysia (Teck *et al*., 2013).

Figure 1. Functional chocolate spread and its applications.

ISSN 1511-7871
9 771511 787001

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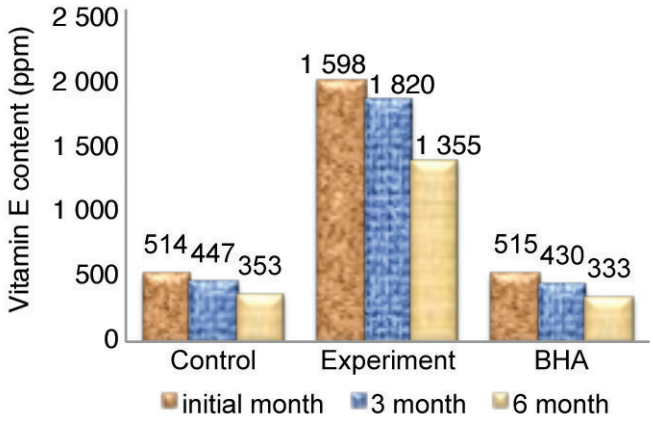
METHOD OF PROCESSING

A ball mill was used in the production of chocolate spread. All ingredients were mixed and ground to small particle size (<20 μm) under a controlled temperature (*Figure 2*). Antioxidant was added at the final stage of processing. Then the viscous product was filled into containers and stabilised in a cold room for 24 hr.

Figure 2. Chocolate spread during mixing and grinding process.

CHARACTERISTICS OF CHOCOLATE SPREAD WITH NATURAL ANTIOXIDANT

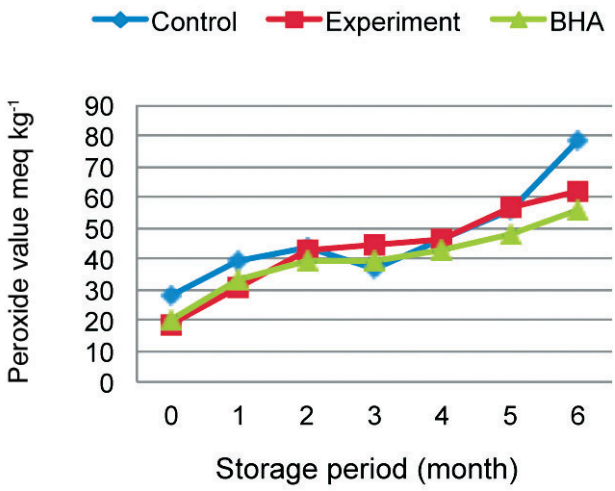
- The spread is smooth and has a pleasant milky chocolate taste.
- The product with palm tocotrienols still retained the vitamin E at 1355 ppm after six months storage, reduced by 30% from the initial month (*Figure 3*).



Note: Control: chocolate spread without antioxidant.
Experiment: chocolate spread with tocotrienols.
BHA: chocolate spread with commercial antioxidant BHA.

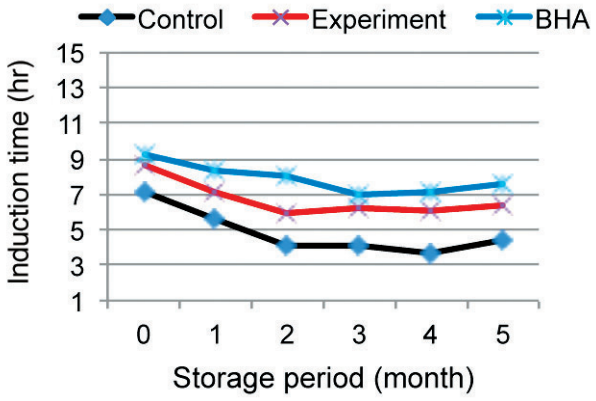
Figure 3. Vitamin E content in chocolate spreads during storage at 30°C over six month.

- The product maintains its stability after six month storage, comparable to the spread with commercial antioxidant, BHA. The levels of PV and induction periods were comparable for both products (*Figures 4* and *5*).
- The product maintains its original taste and flavour after six months storage, and is as good as the control chocolate spread with BHA . No off-flavour was detected (*Table 1*).
- The product is stable without oil separation and maintains its texture even when kept at the ambient conditions of tropical climate.



Note: Control: chocolate spread without antioxidant.
Experiment: chocolate spread with tocotrienols.
BHA: chocolate spread with commercial antioxidant BHA.

Figure 4. Peroxide values of chocolate spreads stored at 30°C for six months.



Note: Control: chocolate spread without antioxidant.
Experiment: chocolate spread with tocotrienols.
BHA: chocolate spread with commercial antioxidant BHA.

Figure 5. Oxidative stability of chocolate spreads during storage at 30°C for six months.

TABLE 1. SENSORY SCORES FOR CHOCOLATE SPREADS WITHOUT ANTIOXIDANT, WITH TOCOTRIENOLS AND BHA AT SIX MONTHS STORAGE

Samples	Smell	Taste	Acceptability
Control	6.3 ab	6.8 a	6.8 a
Experiment	7.4 a	6.2 a	6.8 a
BHA	7.6 a	6.9 a	7.2 a

Note: Control: chocolate spread without antioxidant.
Experiment: chocolate spread with tocotrienols.
BHA: chocolate spread with commercial antioxidant BHA.
Means with the same letter within the same column are not significantly different at $p<0.05$ by Tukey's multiple range tests.

PERFORMANCE OF CHOCOLATE SPREAD

Three formulation of soft and spreadable chocolate spreads were prepared and stored at 30°C for six months to evaluate their performance. These formulations were control formulations without addition of antioxidants and with BHA and experimental formulation with natural antioxidant (palm vitamin E rich in tocotrienols). The samples were evaluated for vitamin E content, degree of oxidation, oxidative stability and sensory evaluation.

Vitamin E Content

The results on vitamin E contents are presented in *Figure 3*. The experimental sample retained 1335 ppm of tocotrienols after six months storage compared to the initial value of 1958 ppm. The level of tocotrienols had only gone down by 30% from the initial value. The control without antioxidant and with BHA chocolate spreads also showed reduced amount of vitamin E after six months storage, each at 353 ppm and 333 ppm respectively. The reduction was in the range of 31% - 35%. Vitamin E for the control and BHA formulations originated from the use of various raw ingredients such as hazelnut paste and soft oil.

Degree of Oxidation

The degree of oxidation of the samples is measured by PV. The PV of the chocolate spreads at 30°C are shown in *Figure 4*. The PV of the spread right after processing was in the range of 18-28 meq kg^{-1} for all the three products. After six months storage at 30°C, the PV were 62 meq kg^{-1} for the products with tocotrienols, 57 meq kg^{-1} for the product with BHA and 78 meq kg^{-1} for the control without antioxidant. Performance of experimental spread with tocotrienols was close to that of the spread with BHA over six months of storage at 30°C.

Oxidative Stability

Oxidative stability was measured with a Metrohm rancimat analyser. The results are shown in *Figure 5*. The initial induction period for the experimental products with tocotrienols was 8.6 hr, and was reduced to 6.4 hr after six months. The initial value for the spread with BHA was 9.2 hr and reduced to 7.6 hr for six months storage whereas in control samples, the value was reduced from 7 hr to 3.8 hr. The result for experimental product was close to product with BHA and they were still stable against oxidation after six months storage at 30°C.

Sensory Evaluation

The scores for acceptability, taste and smell of the experimental, BHA and control chocolate spreads were not significantly different (*Table 1*). The 20 panellists could not distinguish off-flavour or rancidity in all the products that might have developed due to secondary oxidation. Secondary oxidation of the oil and fat can be detected by the presence of aldehydes, ketones, alcohol and acids which cause off-flavours and off-odours and affect the quality of the products (Carelli *et al.*, 2005).

ECONOMIC ANALYSIS

Economic evaluation for the production of chocolate spread is shown in *Table 2*. The analysis was based on the production with plant capacity of 200 kg per run. The assumed market price of the spread was RM 25 per kg. Addition of tocotrienols resulted in an increase cost by only RM 1.40 per kg.

MARKET POTENTIAL

With rapid socio-economic growth in Malaysia and elsewhere, demand for food products with healthy additives, such as vitamins and natural

TABLE 2. ECONOMIC ANALYSIS OF A NEW PLANT (200KG PER RUN) FOR MAKING CHOCOLATE SPREAD

Analyses	Values
Capital investment	RM 500 000
Plant capacity	800 kg day^{-1}
Benefit to cost ratio	1:1.08
Payback period	3 years
Internal rate of return	22 %
Net present value	RM 380114

antioxidants, are booming as consumers are becoming more health-conscious and realise the threat of serious illnesses such as heart disease, cancer and diabetes. The increased health concerns and better informed consumers have influenced on the increasing consumption of functional food products. Trade sources estimated that functional foods in Malaysia comprised 30% - 40% of total processed and retail packed food and drinks market, valued at more than RM 30 billion (Stanton *et al*., 2011; Teck *et al.*, 2013).

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