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A research on interesterified fats in confectionery and chocolate products

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Abstract
Interesterification is a reaction activated by enzymes that results in the random disengagement of polyester fatty acids to the backbone molecules of glycerol. Interesterification changes the fat's physical and chemical properties depending on a change in the position of the molecule and the behaviour of crystallisation. In order to regulate the functionality and crystallisation of the targeted materials, physical and chemical properties play an important role.
In this report, we analysed the Interesterified fats specially baked and various chocolates present in confectionery products. Focus is imposed on enzymatically interesterified fats between baked goods and chocolates. In addition, it is found that the chocolate melting point can be changed and trans fatty acid content ingredients can be produced.

Keywords: interesterification; chocolate; confectionary; enzyme, crystallisation

Introduction
Both fat and oil play an important role in supplying human beings with nutrition. They also assist in improving the quality of food items. In certain cases, pure fat and oils are unable to achieve the desired food properties (such as melting point and instant crystallisation). Therefore, the used techniques require a mixture or other alteration, i.e. hardening, fractionation and interesterification, etc. Fractionation assists in the production of the most economical form so that it is possible to use all fractions. Hardening, on the other hand, is exhaustive because of the need for hydrogen and advanced technological equipment. Whereas enzymatic interesterification, due to the generation of essential Trans fatty acids, replaces hardening. To replicate the properties of costly fats, the physical and chemical properties of fats may be used.
The key contribution of this analysis is to address enzymatic and chemical interesterification in confectionary foods and chocolate technology and also to briefly discuss enzymatic interesterification.

Highlights
- The product of enzymatic interesterification is a directed change of location in fatty acids.
- Interesterified fats are researched and criticised in confectionery products and chocolates.
- It is possible to produce an improvised nutritional product.
- It is possible to calibrate the melting point of chocolate and candy goods.

Fat interesterification methods and principles
The primary factors in determining the physical and chemical properties of TAGs are the location, chain length and saturation level of fatty acids (Triacylglycerides). These are essential for their growth and are also esterified in the backbone molecules of glycerol. In addition, interesterification is also a chemical reaction that helps to exchange fatty acids between triacylglycerols and rearrange specific fatty acids for specific triacylglycerols as well. There are two levels of interesterification: I hydrolysis at the initial state (ii) glycerol moiety esterification. There are certain fatty acids and acyl donors other than triacylglycerols, i.e. alcohol, stearic and palmitic etc. [1-2].

Interesterification using chemicals
Between TAG interesterification, stochastics can be caused using chemical catalysts, i.e. metals, alkali methoxides and ethoxides, etc. This leads to triacylglycerides in which fatty acids are randomly distributed in the glycerol moiety. The batch mode is used in most cases in stochastic systems.
It consists of the steps below:

1. Vacuum drying of fat and sodium hydroxide-based neutralisation.
2. Sodium methoxide is used for subsequent interesterification at 50-90 °C as a catalyst.
3. Citric acid, when inactivated, is applied.
4. The use of water in the removal of the catalyst and the soaps made.
5. The residual water in a vacuum is eliminated.
6. Discoloration and bleaching are used to eliminate methyl esters and residual free fatty acids.The quantity of the initial substrate in the appropriate TAGs is the interterification yield [3-5].

Interesterification using enzymes
The enzymes, called enzymatic interesterification, are also activated by lipase. The ester bonds are hydrolyzed by lipase at unique positions, i.e. one and three, as these positions are of special importance in the glycerol movement, while they are unsaturated at position two and also remain unchanged. The immobilisation of lipase provides high efficiency and pure interesterified oil, regardless of the form of enzyme used, is given. In this process, the substrate that eliminates enzyme inhibitors and residual particles needs to be washed. Deodorant and

neutralisation steps are used to remove the fatty acids in the ongoing process. In order to boost performance and to influence lipase operation, important variables such as residence time, temperature, pH and substrate ratio should be optimised. A particular amount of moisture for the reaction is needed in the hydrolysis process. The enzyme size that decreases the interesterification efficiency in the event of excessive moisture will bind the water molecules.

Efficiency comparison in different processes

The improved method that regulates the specificity of enzymes is enzymatic interesterification. In addition, using time scaling of the reaction, interesterified fats can be obtained and use of dangerous chemicals can also be avoided. In chemical interesterification, high energy input is needed and final clarification can be achieved using side reactions. But enzymatic interesterification is an expensive process, enzyme purity is also another issue, and there is a chance of cross-contamination in the event of a continuous process.

Interesterified fats

Cocoa butter is suspended in liquid chocolate with milk solids, milled cocoa particles and sugar. The flavours of the chocolates differ. The combined effect of stearic acid (36 percent fatty acid) and 25 percent palmitic acid is cocoa butter with a sharp melting point and polymorphic crystallisation. It is esterified with oleic acid at position three or at position one in glycerol and at position two. TAGS are associated with POS (35-38%), POP (15-16%) and SOS (23-26 percent). Cocoa butter is substituted by fats similar to cacao butter. The key criteria for cocoa butter are manufacturing characteristics, fatty acid, melting behaviour, TAG composition and polymorphism. The key problem in the preparation of chocolate is that it is heat resistant with some new flavours and economic aspects. In Europe, the new law restricts the use of cocoa butter to just 5% and allows the alteration of chocolate flavours to refine botanical resources. Different countries have different laws depending on their specifications and standards, e.g., Japan has no limitations on the composition of cocoa butter while the US allows restrictions on cocoa butter. In recent years, interest in cocoa butter alternatives has attracted attention [6].

Cocoa Butter Equivalents With Enzymatic Interesterification

Different substrates for enzymatic interesterification were used for cocoa butter equivalents. Oleic acid comprises mango kernel oil, palm oleic acid, refined pomace olive oil, tea seed oil, sunflower oil and olive oil which, as shown in Table 1, are esterified in the central position of the glycerol backbone. The stearic and palmitic acid used to interterify palm oil hardened the soybean oil. It results in cocoa butter equal to a TAG spectrum and has better thermal behaviour than cocoa butter because soybeans act as an acyl donor. For the purification of fatty acids, mono- and diacylglycerols, subsequent filtration and crystallisation are used. The targeted yield commodity does not identify various studies. Approximately 90 percent of cocoa butter equivalents were achieved in one study based on immobilised R, olive oil as a substrate, stearic acid as an acyl donor and palmitic acid. SOS (19.2 to 24.2), POS (0.3 percent or 41.9 percent), POP (15.1 percent or 11.9 percent) were acquired using high oleic high stearic sunflower in another sample. Various techniques have been applied to analyse the behaviour of crystallisation. For the temperature of 20 °C, induction time increases in this process, the crystallisation phase decreases. In order to increase the number of Alpha crystals, more cocoa butter equivalents have been applied to cocoa butter. There is a polymorphic transition delay due to high concentrations and low melting points, as shown in Figure 1 [7, 8].

Table 1: Enzymatic Interesterification for cocoa butter

Substrate	condition	enzyme	Acyl donor	Reactor
Mango kernel oil	T=35 °C; t=3 d; R= 1: 1	T. lanoginosus, immobilised	Palm oil mod fraction	Stirring
Palm olein	T =60 °C; t= 3 h; R= 1: 3	Rhizomucor miehei, immobilised	Mixture of palmitic and stearic acid	Orbital shaking
Tea seed oil	T= 35 °C; t= 60 h; R=1: 8	Pancreas lipase, immobilised	Methyl palmitate (MP), methyl stearate (MS)	Stirring
Sunflower oil	T= 65 °C; t= 8 h; R= 7: 1	R. miehei, immobilised	Mixture of palmitic, stearic, myristic, and arachidic acid	Stirring
Refined olive pomace oil	T= 45 °C; t= 3 h R=1: 2	R. miehei, immobilised	Palmitic (P) and stearic (S) acid	Orbital shaking

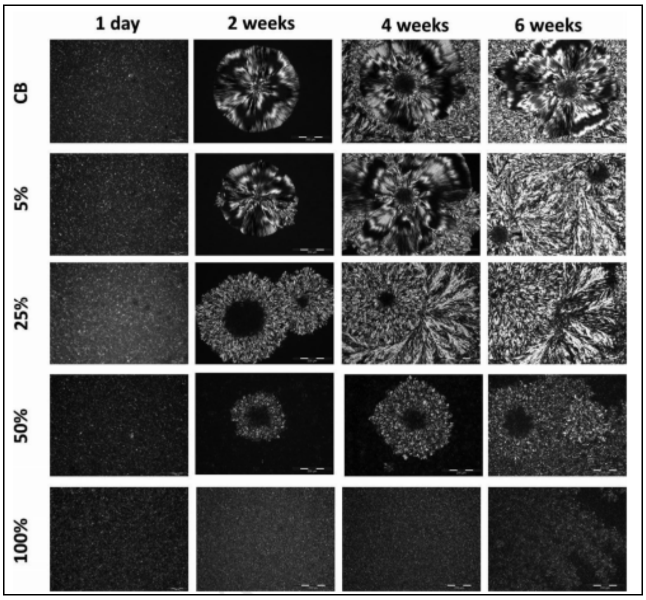

Fig 1: Polarised light micrographs of cocoa butter

Application of Interesterified fats in chocolate Production

The key contributions to promoting cocoa butter equivalent applications in the manufacture of chocolate at the mass level are fat bloom reduction and melting behaviour modification. It is shown in one study that with the addition of 20 percent Cocoa Butter, interesterified tea seed oil decreases the fat bloom and reduces the solid fat content and hardness. In order to maximise the cocoa chocolate butter mixture, pre-crystallisation temperature is also an important factor, influencing not only the fat bloom, but also colour and gloss. Cocoa butter, partly interesterified, also raised the chocolate's melting point. In another analysis, enzymatic interesterification has been found to increase the melting point temperature from 26.0 °C to 42.5 °C. It should therefore be inferred that by manipulating the taste and appearance of chocolate, up to 6.6 percent substitution is possible. Interesterified chocolate HOHS sunflower oil can decrease the temperature and hardness of melting, but it decreases the taste of the flavour. Cocoa butter equivalents can be effectively decreased by enzymatic interesterification.

Interesterified fats: Margarine and shortenings

The effect of margarine and shortenings is Viscoelastic. The key components of semi-solid baking products are crystallised fats. The lubrication in batters and doughs provides fat liquid fraction. Due to dough microstructure and air bubbles, volume production in baking takes place. Shortening is the capacity of the fat to create gluten networks in the dough. Diffusion, moisture, protein hydration and fat are protected by the flour particles, but these are reduced and further contribute to less elastic, shorter and weaker products. In a dough network based on fat crystal functionality that enhances air bubble entrapment, liquid oil can be stabilised.

Baking fats in Enzymatic interesterification

The substrates used in the interesterification of baking fats are beef tallow, palm oil and soybean oil and its fraction. The conditions of development, acyl donors and the source of enzymes are summarised in Table 2. For chemical interesterification and enzymatic substrates, rice bran oil, canola oil, soybean oil and sunflower oil were used. In interesterified goods, SOO and SOS were used and SFC-temperature profiles were subsequently changed.

Table 2: Enzymatic Interesterification for baking fats

Substrate	Condition	Acyl donor	Reactor	Enzyme
Fully hardened soybean oil	T= 60 °C; t=5 h; R= 1: 3	Rice bran oil + coconut oil	Orbital shaking	Thermomyces lanoginosus
Palm stearin	T= 50-70 °C; t= 0.5 - 6 h; R=1: 1.2-5.0	Soybean oil (+ conjugatec linoleic acid)	Different reactor	Thermomyces lanoginosus, immobilised
Beef tallow	T= 60 °C; t= 24 h; R=1:9	Sunflower oil	Orbital	Thermomyces lanoginosus

Baked foods: Interesterified fats

The quantity of fat affects bakery products as follows:

1. Viscosity as manufacturing characteristics in dough
2. Improved baking loss and volume at the time of baking
3. The taste and feel of the final product

Compared to the butter fat compound, sunflower increases dough elasticity. The effect of SFC in the temperature range of 20 - 40 °C is higher density and hardness in the baked goods. The palm oil (75:25) that formulated the standard shortening was replaced by cotton seed oil. Using a high volume of cotton seed oil, which decreases the air density, greater product density can be achieved.

Using low Trans shortening, biscuits are manufactured as volume increases and product hardness increases. Compared to industrial shortening, interest-esterified fats result in better products. Cookies made by shortening advertisements are shown in Fig 2. These use the primary component of sunflower oil. In frying fat for donuts, a higher moisture content is present [9-10].

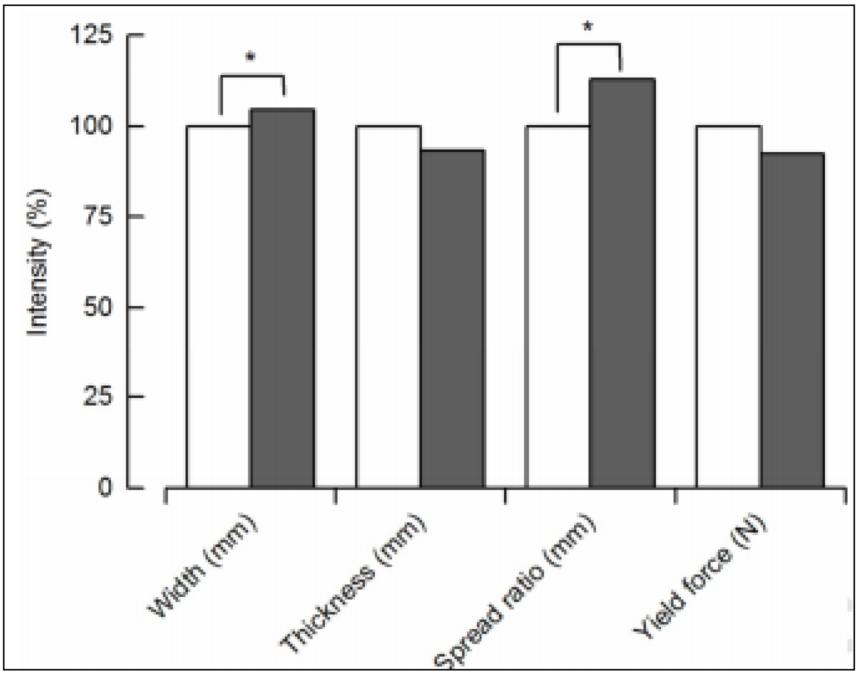

Fig 2: Physical properties of cookies

Conclusion

In this report, the use of enzymatically interfere fats in baked goods and the manufacture of chocolate is estimated to have increased significantly in recent years. Using interesterified fats, the physical properties of the substance are changed. In addition, based on the cocoa butter equivalents, it is found that the trans fatty acid content in baked food and the melting point of chocolate can be increased. This research allows the world to manufacture chocolate and baked goods that are stable and durable.

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