University Research Resource Journal
ISSN : 2581-3730
JAYOTI VIDYAPEETH WOMEN'S UNIVERSITY, JAIPUR
Volume 3, Issue 2: (April to June, 2020)

A study on interesterified fats present in confectionery products and chocolates

Manisha Singh
manishasinghdu22@gmail.com
Jaipur Vidyapeeth Women's University

Acknowledgement to the Originator

I would like to express my special thanks of gratitude to the our Hon'ble Founder & Advisor Dr. Panckaj Garg who is the Originator of this research and their guidance & support. I would like to extend my gratitude for providing mentoring and facilities which was required during the research.

ABSTRACT: A reaction activated by enzymes that result in random disengagement of fatty acids polyester to glycerol backbone molecules is called interesterification. Interesterification affects physical and chemical properties of the fat based on change in the molecule's position and crystallization behavior. Physical and chemical properties play an important role to control the functionality and crystallization of the targeted products. In this study, we reviewed the Interesterified fats present in confectionery products specially baked and different chocolates. Between baked products and chocolates, an emphasis is given on enzymatically interesterified fats. Further, It is found that the melting point of the chocolate can be modified and ingredients having trans fatty acid content can be generated.

Keywords: Interesterification; chocolate; confectionary; enzyme

Scope of Future Research

The main aspects of the paper are to interesterified fats present in confectionery products and chocolates. The main direction is to reduce the fat content and make the product nutritious so that anyone can consume it.

Research Outcomes for Industry/Community/ Government/ Policy Making:

The research outcome of this study is for the industry. The main outcome is the enhancing the confectionary products and enhancing the farmer income through increasing the demands of dairy products. As the demand increases, labour requirement increases from dairy to confectionary production labour as well as scientists and different scholars as well.

INTRODUCTION

Both fat and oils play a significant role in providing nutrition for human beings. They also help in improving food products quality. In most of the cases, desired food properties (like melting point and instant crystallization) cannot be achieved by pure fat and oils. Hence a mixture or some modification is needed in the used techniques i.e. hardening, fractionation and interesterification etc.

University Research Resource Journal
ISSN : 2581-3730
JAYOTI VIDYAPEETH WOMEN'S UNIVERSITY, JAIPUR
Volume 3, Issue 2: (April to June, 2020)

Fractionation helps in developing the most economical method so that all fractions can be used. On the other hand, hardening is the cost exhaustive due to the need of hydrogen and sophisticated technical equipment. Whereas enzymatic interesterification replaces the hardening due to the generation of critical trans fatty acids. Physical and chemical properties of the fats can be used to imitate the properties of expensive fats. The main contribution of this study is to discuss enzymatic and chemical interesterification and also brief about enzymatic interesterification in confectionary foods and chocolate technology.

Highlights

- A directed position change in fatty acids is the result of enzymatic interesterification.
- Interesterified fats present in confectionery products and chocolates are studied and criticised.
- An improvise nutritious product can be developed.
- Melting point in the chocolate and confectionary products can be calibrated.

Fat interesterification methods and principles

Position, chain length and saturation degree of fatty acids are the main constituent factors in deciding the physical and chemical properties of TAGs(Triacylglycerides). These are essential for their growth and also esterified in the glycerol backbone molecules. Further, interesterification is also a chemical reaction that helps in exchanging the fatty acids between Triacylglycerides and also rearranges the specific fatty acids for the particular Triacylglycerides.

Interesterification comprises two steps: (i) hydrolysis at the initial state (ii) Esterification of the glycerol moiety. Other than triacylglycerols, there are some fatty acids and acyl donors i.e. alcohols, stearic and palmitic etc [1-2].

Interesterification using chemicals

Stochastic can be induced between TAG interesterification using chemical catalysts i.e. metals, alkali methoxides and ethoxides etc. It results in triacylglycerides where fatty acids are distributed randomly throughout the glycerol moiety. Batch mode is used in stochastic processes in most of the cases. It consists of the following steps:

(i) Fat drying in vacuum and neutralized based on sodium hydroxide.

(ii) Sodium methoxide is used as a catalyst in subsequent interesterification at 50-90 °C.

(iii) Citric acid is added in its inactivation.

(iv) Use of water in removing the catalyst and the formed soaps.

(v) In vacuum residual water is removed.

(vi) Methyl esters and residual free fatty acids are removed using desodoration and bleaching.

The quantity of initial substrate is interesterification yield in the desired TAGs [3-5].

Interesterification using enzymes

Lipase is also used to trigger the enzymes that are called enzymatically interesterification. Lipase hydrolyse the ester bonds at specific positions i.e. one and three, as these positions are of specific interest in glycerol moiety whereas at position two is unsaturated and also remain unaffected. Lipase immobilisation provides high efficiency and provides the pure interesterified oil which is independent of the type of enzyme used. In this process, it is necessary to clean the substrate which removes enzyme inhibitors and residual particles. In the ongoing process, desodoration and neutralisation steps are used to extract the fatty acids. Important factors like Residence time, temperature, pH and substrate ratio should be optimised to improve the efficiency and to influence the lipases activity. In the hydrolysis process, a specific amount of moisture is needed for the reaction. As the water molecules can bind the enzyme size that reduces the interesterification efficiency in case of excessive moisture.

REVIEW OF LITERATURE

Enzymatic interesterification is the better process which controls the specificity of enzymes. Further, interesterified fats can be obtained using time scaling of the reaction and also use of hazardous chemicals can be avoided. High energy input is needed in chemical interesterification and final clarification can be achieved using side reactions. But enzymatic interesterification is a costly process, enzyme purity is also another issue and incase of continuous process there is the risk of cross contamination.

In liquid chocolate, cocoa butter is suspended with milk solids, milled cocoa particles and sugar. It varies from flavours of chocolates. Cocoa butter with sharp melting point and polymorphic crystallization is the combined effect of stearic acid (fatty acids with 36%) and 25 % palmitic acid. It is esterified at position three or at position one in glycerol and position two is esterified with oleic acid. TAGS are consistent with POS (35-38%), POP (15-16%) and SOS (23-26%).

Cocoa butter is replaced by Cocoa butter equivalent fats. Processing properties, fatty acid, melting behaviour, TAG composition and polymorphism are the main requirements in cocoa butter. Heat resistant with some new flavours and economical aspects are the main concern in preparation of the chocolate. In Europe, current regulation limits the use of cocoa butter equivalent to 5% only and botanical resources are allowed to refine the modification in chocolate flavours. Different countries have different regulations based on their requirements and standard e.g Japan has no limitation in cocoa butter composition whereas the US allows cocoa butter with restrictions. Interesterification of cocoa butter equivalents has drawn attention in recent years [6].

ISSN : 2581-3730

Cocoa butter equivalents with enzymatic interesterification

Cocoa butter equivalents used different substrates for enzymatic interesterification. Oleic acid contains mango kernel oil, palm olein, refined olive pomace oil, tea seed oil, sunflower oil and olive oil that are esterified at the central position of the glycerol backbone as mentioned in Table 1. Stearic acid and palmitic used in the interesterification of palm oil, it hardened the soyabean oil. As soybean acts as acyl donor, it results in cocoa butter equivalent with a TAG spectrum and has better thermal behavior than cocoa butter. Subsequent filtration and crystallisation is used to purify the fatty acids, mono- and diacylglycerols. Various studies don't specify the targeted yield product. In one study cocoa butter equivalent achieved approximately 90% based on immobilised R, olive oil as substrate, stearic acid as acyl donors and palmitic acid. In another study, SOS (19.2 to 24.2), POS (0.3% or 41.9%), POP (15.1% or 11.9%) obtained using high oleic high stearic sunflower. To analyse the behavior of crystallisation, various methods have been applied. In this process induction time increases for the temperature 20 °C, crystallization step decreases. Further cocoa butter equivalents were added to cocoa butter to increase the number of α crystals. Due to high concentration and low melting points, there is polymorphic transition delay 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

University Research Resource Journal
ISSN : 2581-3730
JAYOTI VIDYAPEETH WOMEN'S UNIVERSITY, JAIPUR
Volume 3, Issue 2: (April to June, 2020)

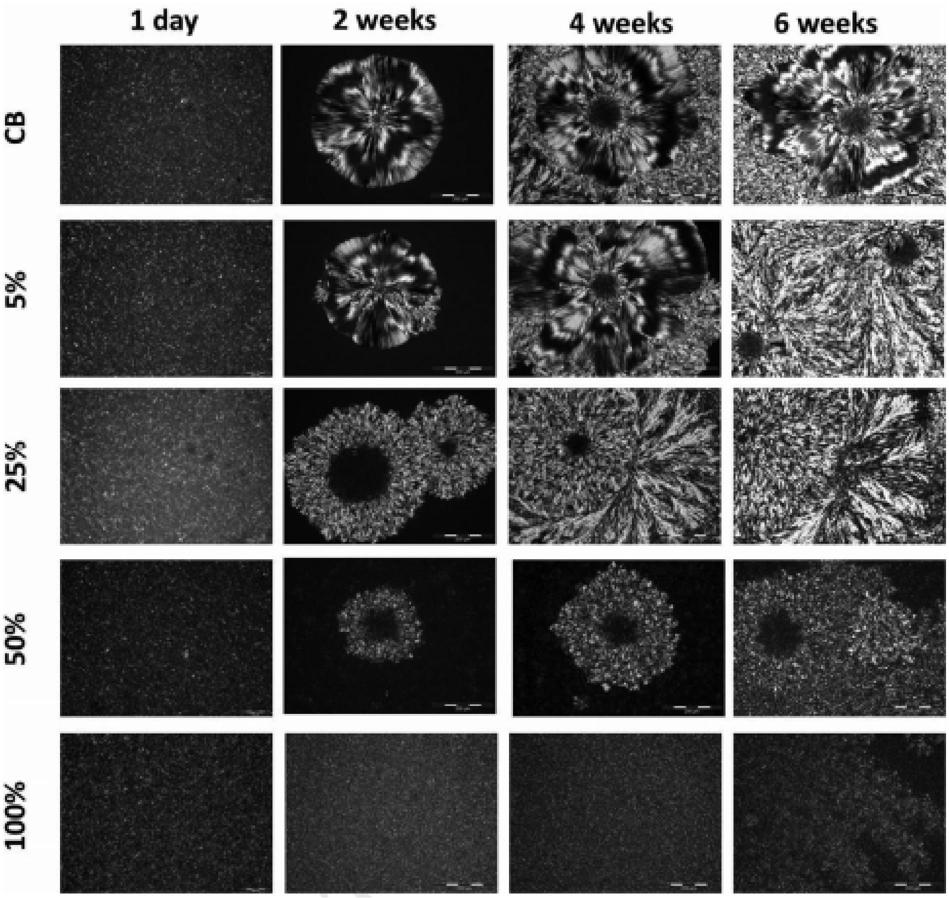

Figure 1: Polarised light micrographs of cocoa butter

Application of interesterified fats in chocolate production

Fat bloom reduction and melting behaviour modification are the main contributions to foster cocoa butter equivalent applications in the production of chocolate at the mass level. In one study, it is shown that interesterified tea seed oil with the addition of 20% Cocoa Butter Reduces the fat bloom and lowers the solid fat content and hardness. Pre-crystallisation temperature is also an important factor to optimise the cocoa chocolate butter mixture, it not only affects the fat bloom but also colour and gloss. Partly interesterified Cocoa butter also increased the melting point of the chocolate. In another study, it is found that enzymatic interesterification increases the temperature of melting point from 26.0 °C to 42.5 °C. Hence it is to be concluded that up to 6.6% replacement is possible by affecting the taste and appearance of chocolate. Interesterified HOHS sunflower oil in chocolate can decrease the melting temperature and hardness but it reduces the flavour taste. Enzymatic interesterification can successfully reduce the cocoa butter equivalents.

Interesterified fats: Margarine and shortenings

Viscoelastic is the effect of margarine and shortenings. Crystallized fats are main constituents in semi-solid baking ingredients. Fat liquid fraction provides the lubrication in batters and doughs.

Volume development in baking takes place because of dough microstructure and air bubbles. Shortening is the fat ability to develop gluten networks in dough. As the flour particles cover the diffusion, moisture, protein hydration and fat, but these are limited and further leads to less elastic, shorter and softer products. Liquid oil can be stabilized in a dough network based on fat crystal functionality which improves air bubble entrapment.

Baking fats in Enzymatic interesterification

Beef tallow, palm oil and soybean oil and its fraction are substrates that have been used in baking fats interesterification. Production conditions, acyl donors and enzyme source are summarized in Table 2. Rice bran oil, canola oil, soybean oil and sunflower oil were used in chemical interesterification and also as substrates for enzymatic. SOO and SOS were used in interesterified products and consequently SFC-temperature profiles were modified.

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

Bakery products are affected by the fat quantity as follows:

(i) Viscosity as processing properties in dough

(ii) Baking loss and volume enhanced at the time of baking

(iii) Flavour and texture of the end product

Sunflower increases the dough elasticity as compared to the butter fat compound. Higher density and hardness in the baked products is the result of SFC in the temperature range 20 - 40 °C . Cotton seed oil was replaced by palm oil (75:25) that formulated the regular shortening. Higher product density can be achieved using a high amount of cotton seed oil which reduces the air density. Biscuits are made using low trans shortening as volume increases and hardness of the product increases. Interesterified fats result in better products as compared to commercial shortening. Cookies made with commercials shortening are shown in fig 2. These use sunflower oil as the main constituent. Higher moisture content is present in frying fat for donuts [9-10].

University Research Resource Journal
ISSN : 2581-3730
JAYOTI VIDYAPEETH WOMEN'S UNIVERSITY, JAIPUR
Volume 3, Issue 2: (April to June, 2020)

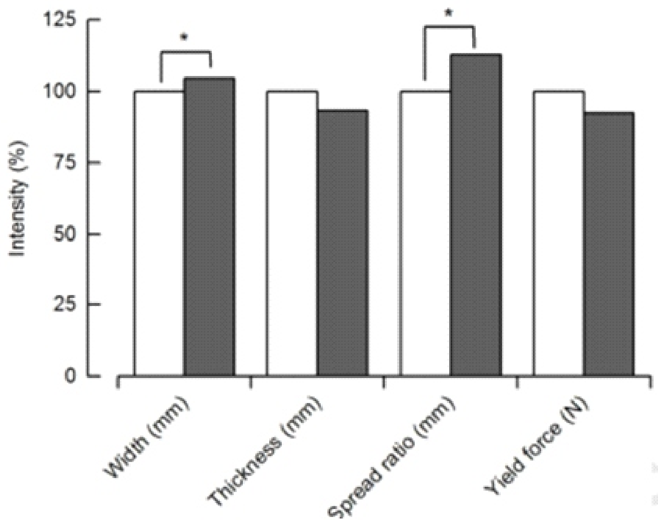

Figure 2: Physical properties of cookies

Conclusion

In this study, it is estimated that the use of enzymatically interesterified fats in baked foods and chocolate production have increased significantly in the recent years. The physical properties of the product are modified using interesterified fats. Further it is found that trans fatty acid content in baked food and melting point of chocolate can be increased based on the cocoa butter equivalents. This study helps the world in producing stable and durable chocolate and baked products

References

[1]. Rohm, H., Schäper, C., Zahn, S., Interesterified fats in chocolate and bakery products: A concise review, LWT - Food Science and Technology (2017), doi: 10.1016/j.lwt.2017.08.076.

[2]. Y., Li, J., & Zheng, J.-X. (2014). Estimation of the caloric value of low-calorie cocoa butter and evaluation of its effects on biochemical and physiological parameters of rats fed high-fat diet in vivo: Estimation of the caloric value of low-calorie cocoa butter. European Journal of Lipid Science and Technology, 116, 108-118.

[3]. Wassell, P. (2014). Bakery fats. In K. K. Rajah (Ed.), Fats in food technology (pp. 39-82). Chichester, UK: Wiley-Blackwell.

[4]. Ozturk, S., Ozbas, O. O., Javidipour, I., Koksel, H. (2009). Effects of zero-trans inte344 resterified and non-interesterified shortenings and brewer's spent grain on cookie 345 quality. Journal of Food Lipids, 16, 297-313.

[5]. Adhikari, P., Hu, P., & Yafei, Z. (2012). Oxidative stabilities of enzymatically interesterified fats containing conjugated linoleic acid. Journal of the American Oil Chemists' Society, 89, 1961-1970.

[6]. Agyare, K. K., Xiong, Y. L., Addo, K., & Akoh, C. C. (2006). Dynamic rheological and thermal properties of soft wheat flour dough containing structured lipid. Journal of Food Science, 69, 297-302.

[7]. Wu, W.-L., Pan, L.-Y., Tan, Z.-Q., Yuan, L., Zhu, W.-L., Li, X.-M., Liang, D.-P., Zhou, Y., Li, J., & Zheng, J.-X. (2014). Estimation of the caloric value of low-calorie cocoa butter and evaluation of its effects on biochemical and physiological parameters of rats fed high-fat diet in vivo: Estimation of the caloric value of low-calorie cocoa butter. European Journal of Lipid Science and Technology, 116, 108-118.

[8]. Peluffo, A. 1929. Action lipasique de la salive. Compt. Rend. Soc. Biol. 100:115.

[9] Peric-Golia, L., and H. Socic. 1968. Biliary bile acids and cholesterol in developing sheep. Amer. J. Physiol. 215:1284.

[10] Wise, G. H., P. G. Miller, G. W. Anderson, and A. C. Linnerud. 1976. Changes in milk products sham fed to calves. IV. Suckling from a nurse cow versus consuming from either a nipple feeder or an open pail. J. Dairy Sci. 59:97.