Original Article

A manufacturer's perspective on selected palm-based products

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An overview from the perspective of one manufacturer is provided on products that utilise either palm oil or palm kernel oil. The manufacturer is Macphie of Glenbervie while the products are of a wide-ranging nature for use in bakery, food service and food-manufacturing. Much of the discussion concerns cream alternatives on the grounds that this product-category places great demand on the type of fat needed and, to Macphie of Glenbervie, is responsible for most of the oil from oil palm used. However, other products are also touched on. The overview considers key product attributes the function that fat has within these products, together with research requirements and future opportunity.

Key Words: fat functionality, palm functionality, palm kernel functionality, HPKO functionality, cream alternatives, vegetable cream, imitation cream, non-dairy cream, food emulsions, food industry perspective on fat

Introduction

It is obvious that an industrial food producer is focussed first and foremost on commercial considerations and not on academic matters. In other words, while manufacturers may be steered by science/technology, and are able to commission scientific works, the development of scientific understanding is not their raison d'être. Nevertheless, manufacturers do hold views on their products, and the technology of their products, which are often worth hearing. After all, by so doing, it provides an opportunity for steering academia towards commercially relevant matters or, looking at another way, for such views to be challenged by independent study.

This paper should be considered in such a way: an airing of views as perceived by one manufacturer; in this instance, the manufacturer Macphie of Glenbervie (MoG). More specifically, an overview is provided on products made by MoG that utilise palm or palm kernel oil, together with thoughts on how these fats impact on product function and product quality.

As for a little background to the company and its interests, MoG manufactures a wide range of speciality food products intended for: (i) the bakery trade, (ii) food service outlets, and (iii) other food manufacturers. While most of MoG's business is in the UK, its overseas business is not insubstantial. A key to the success of the business is its focus on five core product categories, namely: cream alternatives, enriched bread products, cake mixes, sweet/savoury sauces and bakery glazes. However, it is right to point out that, in line with the company's approach to embrace flexibility within the market place, this list is not exhaustive and other product types are manufactured also. Clearly there is a requirement for fat of some nature across the complete range of products, and MoG's need is met principally with hardened palm kernel oil (HPKO), a blend of hydrogenated palm and rapeseed oil, and pure rapeseed oil. However, it is not surprising to say that HPKO represents the greatest usage of 'palm products' and that it is used almost entirely in the manufacture of cream alternatives (CAs). Accordingly, while a little further reference will be given to the fat requirements of the other four core-product categories, it is the CAs that will be given most consideration in this paper.

Methods

Total free fatty acid was determined on selected samples of CA using an independent and accredited laboratory. Here, samples were dissolved in 1:1 (v/v) hexane-diethyl ether containing 0.2N sulphuric acid and passed through an alumina column; the extract was then analysed by GC with flame-ionisation detection. For analysis of headspace, the same laboratory was used. Using a Lickens-Nickerson co-distillation apparatus in a four-hour extraction, volatiles from the CA were collected in pentane-diethyl ether-toluene (540:60:1). The extract was then filtered, dried and concentrated prior to analysis by GC/MS.

Cream alternatives

What are these and why do they sell?

Cream alternatives go under several names, such as 'topping', 'non-dairy cream', 'imitation cream' and 'vegetable cream', but they have one common purpose, namely, to provide some advantage over dairy cream. Often these products are manufactured by UHT processing and supplied as ambient-stable, aseptically-packaged liquids. A generalised listing of ingredients for a CA is provided in Table 1.

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Table 1. Ingredients typically used in a CA

20-35% fat; chiefly lauric-based fat with some dairy fat
0-25% sugar(s)
0.5-2.5% milk protein
0.2–1.0% emulsifier
0.1–0.4% gum
Optional colour and flavour

The tolerances of any individual CA are, of course, dependent upon the specifics of its formulation which, for example, could be designed to have some benefit over dairy cream in cooking. But, more usually, it is the whipping-properties of the CA that are seen as particularly desirable and which drives market use. Specifically, besides the convenience of ambient stability and asepsis, CAs relative to dairy cream can offer whipped toppings that are more economical, contain less fat (particularly when fat is considered on a weight/volume basis in the 'whip'), are more robust to collapse and weeping (and can be freeze-thaw stable), are more resistant to becoming buttery with over-beating, have a fine bubble structure (which is desirable in cake decoration), and can be very white (which is desirable to certain cultures). However, while such benefits are not only possible but commonplace, it should also be remembered that dairy cream finds considerably greater use than the CAs. So, for those that would wish to see CAs with a greater market share, including such businesses as MoG, this provides impetus for increasing the strengths and diminishing the weaknesses yet further relative to dairy cream.

How do these whip?

Prior to whipping, a CA consists of an oil-in-water emulsion – typically containing fat particles of very small size (2 µm or less). For a product aimed at being convenient and of long shelf-life, it is imperative that adequate emulsion-stability is provided. That is, ideally the CA should not exhibit significant degrees of flocculation, coalescence or creaming through usual storage practices. It is fair to say that this is seen in the best examples of a CA and is achieved by a combination of processing considerations, together with a thoughtful selection of proteins, emulsifiers and polysaccharide hydrocolloids – such that satisfactory interfaces and bulk-phase properties are created.[1]

The interface of a CA is thought to be a mixture of proteins and emulsifiers, while the most important modifiers of the properties of the bulk phase are likely to be proteins and polysaccharide hydrocolloids.[2] Immediately before whipping, almost invariably a CA will be chilled to less than 10ºC. There is evidence that by chilling the CA there are ensuing changes to the inter-facial properties.[3] More important, however, is an increased solidification of the lauric fat which is a prerequisite for satisfactory whipping.[2]

As for the whipping itself, it is thought that bubbles are initially stabilised by protein from the bulk phase. Such bubbles become more finely divided and, progressively, associated with the particles of fat. Meanwhile, there is a noticeable increase to the firmness of the whip. It is generally thought that, as a consequence of shear, there is a partial coalescence of the fat particles. As the network of partially coalesced fat particles develops, so too does whip-firmness until, ultimately, the whip is said to be 'gathered'. A schematic for the structure of a whipped CA is shown in Figure 1.

Practically, whipping can be achieved using a variety of commercial machines, from familiar planetary mixers to less familiar continuous aerator-types that use a combination of air-aspiration and shear. A stylised whip using a planetary mixer is shown in Figure 2 where it can be seen that 'gather' typically occurs after a point of maximum over-run has been passed. Beyond the point of 'gather', firmness tends to continue to increase, over-run continues to be lost, and 'butteriness' becomes perceptible in the mouth. A CA that is tolerant to over-whipping would be expected to develop such undesirable attributes to a lesser extent or, at least, more slowly.

What are the technical issues?

It is clear that the above description on whipping is little more than a sketch. While this is a short paper, able to provide a brief overview only, it is also true that a more detailed review could add little to this basic sketch. Furthermore, even the scheme presented here is supported by little published work. Rather, the scheme for the whipping of a CA has been borrowed almost entirely from the more extensive studies made on dairy cream.[4-6]

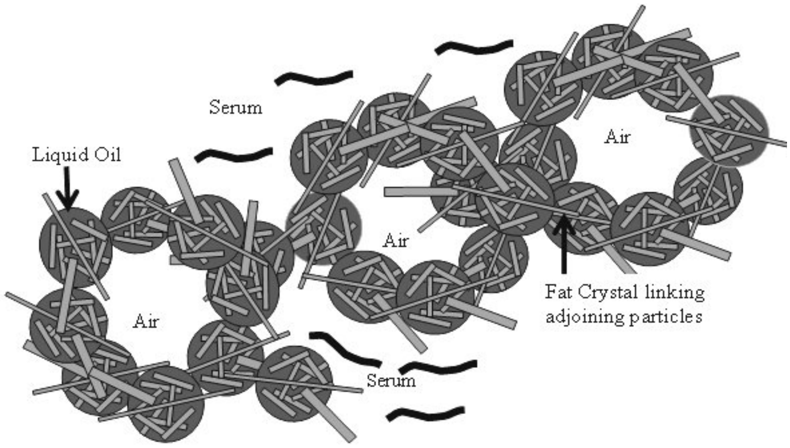

Figure 1. Structure of whipped CA: bubbles surrounded by fat particles which, in turn, are linked by partial coalescence to give texture.

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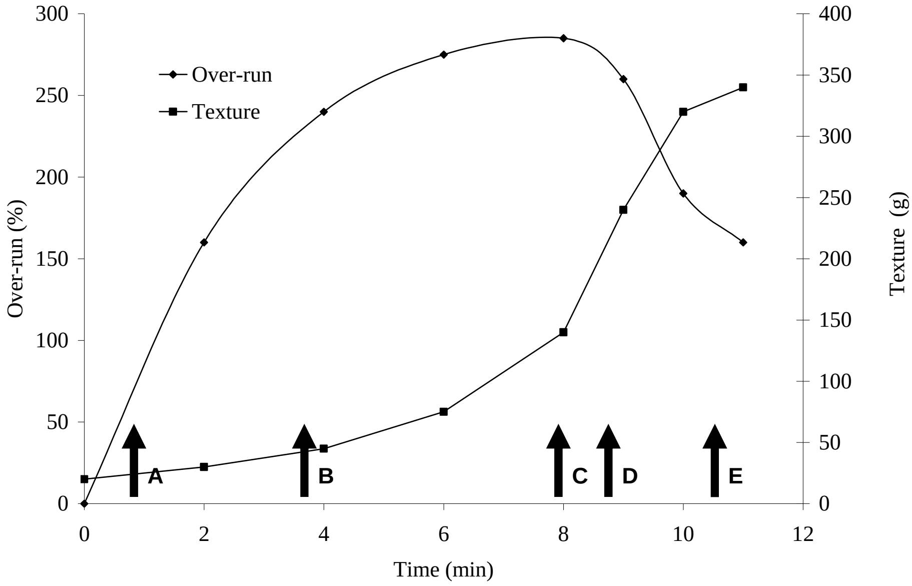

Figure 2. Stylised whip-profile of CA using a planetary mixer: air cells are introduced which are thought to be stabilised initially by protein (A); progressively more air is introduced, air cells become finer and associated with particles of fat, meanwhile the texture of the CA becomes firmer which is believed to be by partial coalescence of fat (B); a maximum over-run is achieved (C), so-called 'gather' occurs when the texture of CA finds widespread acceptance for subsequent use (D); with over-whipping, volume is lost and the texture continues to increase, often with the formation of fatty aggregates (E).

It is known, however, that there are many significant distinctions between a CA and dairy cream; for example, relative to a dairy cream, typically a CA: will contain fat of higher solids, will contain smaller fat particles, will contain less total fat, and can generate higher over-run. So, in other words, the current understanding of CAs is speculative and incomplete. However, there is no reasonable doubt that, while the performance of a CA may be influenced by a great many factors, the presence of lauric fat is the single-most critical. Ultimately it is this inclusion that allows a CA to whip and, simply, without such fat CAs would not exist. A more thorough understanding of CAs and, in particular, the role played by lauric fat would seem deserving therefore and would provide a means for greater control of the whip properties.

A specific case study

By way of example of the need for greater understanding, albeit in relation to taint rather than whipping, some brief details are provided of a specific commercial problem that has been encountered. It is widely known that lauric fat is prone to the development of taint after a small degree of hydrolysis, liberating small-chain free fatty acids (FFA) which are perceived as being 'soapy'. Such taint was noted sporadically in one specific CA and assumed to be a case of such hydrolytic rancidity. Moreover, at the outset it was anticipated that such hydrolysis occurred because of contamination with a source of lipase. However, after considerable testing, no evidence was found to support this viewpoint and, rather, tainted samples seemed to contain no more FFA than non-tainted samples (it is neither possible nor appropriate to give all details of such testing but Table 2 gives the results of FFA from one specific analysis undertaken in this regard). Furthermore,

Table 2. Total FFA in selected tainted and non-tainted CA

FFA (mg/ kg)	Tainted CA	Non-tainted CA
Caprylic acid (C8)	114	127
Capric acid (C10)	85	95
Lauric acid (C12)	1009	1324

it was also unclear why other CAs manufactured on the same plant and sharing the same ingredients (although to different formulations) did not develop taint. On the other hand, once headspace analysis had been executed – using the Lickens-Nickerson procedure to generate the extract – there was a clear instance of more FFA in the tainted sample than in the non-tainted ones. This is shown in Figure 3 and it should be noted that the samples tested here were the same as that which gave rise to the results in Table 2.

The interpretation of these results was that since there was no overall difference in the level of FFA between tainted and non-tainted sample, yet the tainted sample clearly had more FFA in its headspace (which would obviously impact on its flavour), there had to be a physical difference that affected the volatility of FFA. It was further reasoned that such a physical difference had to relate to some change to the state of the emulsion and, assuming that the CA giving taint was less stable than the other products (i.e. other CAs within the range that did not give rise to taint), this would explain why the problem was not generic.

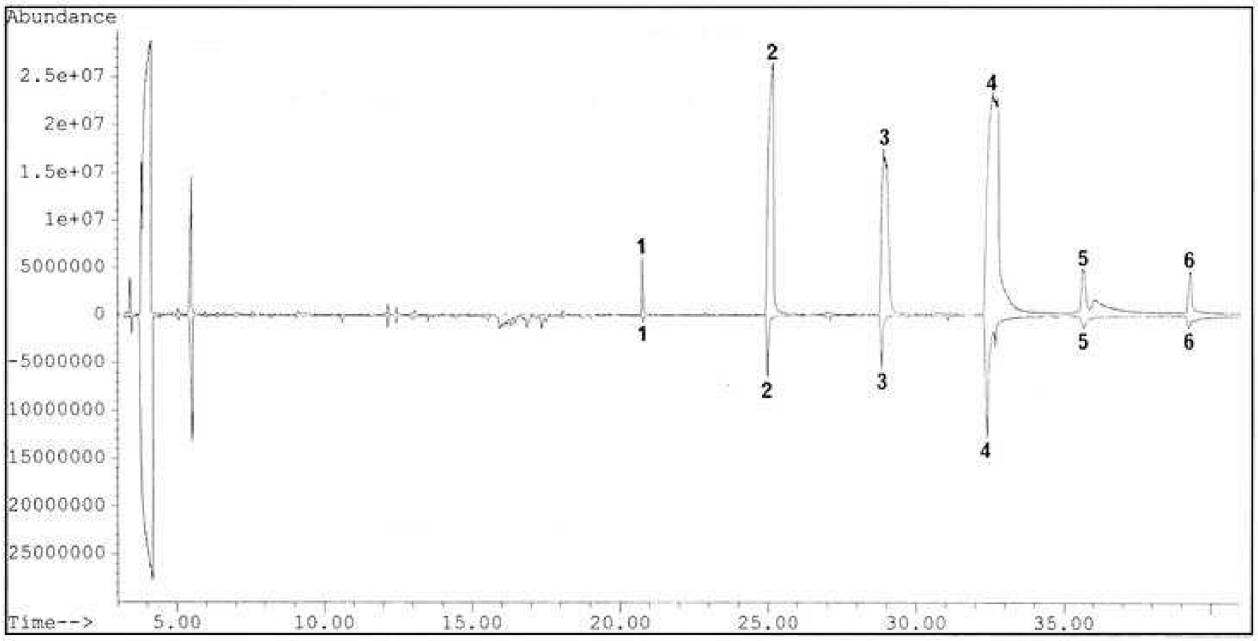

Figure 3. Lickens-Nickerson headspace-extract, analysed by GC/MS, of selected tainted and non-tainted CAs; chromatograms inverted relative to each other for ease of comparison. Key: 1 = caproic acid (C6), 2 = caprylic acid (C8), 3 = capric acid (C10), 4 = lauric acid (C12), 5 = myristic acid (C14), 6 = palmitic acid (C16).

It is of course acknowledged that many could be sceptical that taint can be affected by the state of the emulsion. Nevertheless, in the interests of delivering a commercial solution, this view was taken and the product reformulated to give improved emulsion-stability. On so doing, there has no been reoccurrence of taint.

If it can be accepted that the explanation offered here is correct, to the authors there seems no underlying mechanism known (or least known to the authors) and to establish such knowledge would seem of profound interest.

Other MoG products

At MoG, hardened palm oil is used in a blend of fat in combination with hydrogenated rapeseed oil and finds use across practically the full range of products that are manufactured. Often the hydrogenated fat is blended further with varying proportions of rapeseed oil. There are three principal reasons for MoG's use of such fat: (i) to many foods it can add 'richness' (simply by virtue of the inclusion of fat), (ii) to bakery products it provides fat that remains solid at proof temperature, thereby avoiding 'fat-failure' in bread or bread-like products made by high-energy mixing[7], and (iii) to many so-called paste-products, which are food-concentrates where ingredients have been suspended in an oil phase, it provides sufficient rigidity to prevent sedimentation.

With regard to the latter, such pastes are often formulated to be as soft as possible, so that they are easy to dispense and disperse during use, while at the same time being of sufficient firmness to suspend particulates. Since formulations can be a balance between these conflicting demands, occasional problems can occur in commercial practice such that either sedimentation or handling-issues may arise. However, the functional requirements for hardened palm oil in these products are not highly demanding and, in all likelihood, can be provided readily with other choices of oil and/or hardened fat. As such, provided the oil/fat is of consistent quality, cost is a principal consideration to the sourcing of fat. But, it is also worth noting that an undesirability of *trans* fatty acids seems to be falling more in the media spotlight and this could provide motivation for selecting fats differently in times ahead. Moreover, it seems likely that speciality fats from the oil palm, which avoid hydrogenation and generation of *trans* fatty acid, will become more attractive to food producers. While CAs are not unaffected by this same concern (remembering that these use HPKO), the higher technical demand on the fat and the lower level of *trans* fatty acid from HPKO makes the concern less.

Conclusion

The requirements for palm oil and palm kernel oil have been considered in the context of one manufacturer, namely MoG. The CAs account for the bulk of the palm-fat used by this manufacturer and it is this product-class that places the most demand on the nature of fat. Essentially, lauric fat, such as palm kernel oil, provides the basis for a CA that tastes and whips like dairy cream. It has been said that there is need for an improved technical understanding of CAs and, in particular, the role that lauric fat plays in this product-class during whipping. From a commercial viewpoint, such work can help to deliver more consistent, versatile, tolerant, better tasting and cost-effective products. Or, in other words, such work can help to bring more market-share to the CAs – which is in the interest of the palm-producer and palm-user alike.

Small mention has also been made of other products that use hydrogenated palm oil within a vegetable oil blend. Here the technical requirements are rather more general but, of course, the usual request for improved consistency at lower cost would apply. To both CAs and the broad grouping of 'other' products, it is desirable to meet consumer health concerns as far as is practical. In particular, concerns over *trans* fatty acids seem to be

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growing which may mean an opportunity for speciality palm products in place of the existing hydrogenated fats.

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A manufacturer's perspective on selected palm-based products
制造商对选择棕榈产品的看法

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概述了制造商对棕榈油或棕榈核仁油应用的总体看法。 文章涉及的制造商为 Glenbervie 的 Macphie，涉及的产品为用于面包店、食品供应以及食品制造的多种品质的棕榈产品。文章主要讨论了奶油的替代品——因为产品种类对所需的脂肪类型有很高要求，而且，对 Glenbervie 的 Macphie 来说，大部分产品种类要求使用棕榈油。当然，其他产品也有所涉及。文章思考了造成这些产品中脂肪的特定功能关键产品，并指出了继续研究的需要以及未来的发展机遇。

关键词：脂肪的功能性， 棕榈的功能性，棕榈核仁的功能性，HPKO 的功能性，奶油的替代品，蔬菜奶油，仿制稀奶油，非乳制奶油，食品乳化剂，脂肪在食品工业中的前景