Ice cream dream

With the rise of low-carbohydrate diets, ice cream manufacturers must find new ways to adapt their products to a slimming market. Dr Bruce W Tharp of Tharp's Food Technology looks at the various ingredients used to cut the carbohydrate content of frozen desserts.

Dieters can indulge themselves with low-carb ice cream

There has been a global surge of interest in diets that reduce carbohydrate intake. The frozen dessert industry must address this trend to survive in the evolving marketplace. Producers need to adopt technologies to produce an ice cream that will appeal to carbohydrate watchers, while maintaining the smoothness and creaminess associated with conventional products.

There are a number of vernacular terms associated with dietary regimes, such as the Atkins diet. Carbohydrates with a high glycemic index are referred to as 'bad carbs', while those with a low index are called 'good carbs'. Since the Atkins diet concept uses the term 'net carbs' to refer to the latter, the term 'low net carb' (LNC) is often used to identify foods appealing to those following the Atkins diet or similar programmes.

Supplementing sugars

Conventional sweetener systems (CSS) make contributions to frozen products that go beyond their obvious sweetening qualities. These include bulking effects, water immobilisation and freezing-point control. A conventional sweetener system makes up about half the solids of a typical ice cream, so it is a significant bulking agent. The water immobilisation properties of high molecular weight components in CSS are responsible for control over ice crystal growth, mouth feel and shape retention. Also, the sweetener system is a major factor in determining the ice cream freezing-point. Replacing conventional sweeteners with good carb alternatives that affect this freezing-point might cause problems when the product has to be frozen for a considerable length of time.

Ingredient groups that effectively supply a broad range of conventional sweetener functions in LNC ice cream include: sugar alcohols (commonly referred to as 'polyols'), bulking agents, modified MSNF sources, stabiliser/emulsifier systems and high intensity sweeteners. These groups vary in their functions and characteristics (see Table 1).

High-intensity sweeteners

When the sweetness produced by the carbohydrate system in a frozen dessert is inadequate, the difference must be made up by the use of a high-intensity sweetener. This is usually chosen from a group that includes aspartame, sucralose and acesulfame K. The selection of the type and level of high-intensity sweetener used is based on economic factors, and the nature and intensity of the sweetness desired. High-intensity sweeteners are used in relatively low doses so, other than sweetness, they make no other contribution to the quality of ice cream.

The polyols currently used to enhance LNC ice cream in the USA are: sorbitol (dextrose), lactitol (lactose), maltitol (maltose), erythritol (yeast fermentation of dextrose) and glycerine (a three-carbon alcohol produced synthetically, or as a by-product of soap manufacture). Sorbitol is the most commonly used polyol for LNC ice creams, followed by lactitol and maltitol. Glycerine is occasionally included, and erythritol is just beginning to gain approval.

Freezing-point depression

When using lactitol and maltitol, the effect of freezing-point depression is comparable to that of sucrose. This makes them useful in managing the freezing profile of LNC ice cream. However, their costs are higher than that of sorbitol. In the case of lactitol, the economic factors are compounded by a relatively low level of sweetness, which increases the amount of costly, high-intensity sweetener required. Lactitol also has a very low laxation threshold. Maltitol, on the other hand, has a sweetness that is nearly the same as that of sucrose and a very high laxation threshold.

Glycerine is useful because of its strong freezing-point depression effect. However, its use is limited by its laxative effect, its potential to alter flavour and by the possibility of an adverse consumer reaction to its presence.

Erythritol is valuable in LNC products because of its low calorie contribution and high laxation threshold. However, its low molecular weight produces a high degree of freezing-point depression. With judicious use, erythritol can be used to develop products that have

Table 1. The role of ingredients replacing sweetener functionality in LNC ice cream

	SWEETNESS	BULKING	WATER IMMOBILISATION	FREEZING-POINT INFLUENCE
Polyols				
Sorbitol[1]	Yes	Yes	No	Yes
Lactitol[1]	Yes	Yes	No	Yes
Maltitol[1]	Yes	Yes	No	Yes
Erythritol[1]	Yes	Yes	No	Yes
Glycerine[1,2]	Minor	Minor	No	Yes
Bulking Agents				
Polyglycitol[2,3,6]	Yes	Yes	Yes	Yes
Polydextrose[1,2,3]	No	Yes	Minor	Yes
Maltodextrin	No	Yes	Yes	Minor
Other Ingredients				
Milk protein concentrates[2,4]	No	Minor	Yes	Yes
Stabiliser/emulsifier systems[3,4,5]	No	No	Yes	No

Notes:
[1] Limited by laxative effects
[2] Limited by flavour contribution
[3] Effect variable with type and source
[4] Limited by potential viscosity effect
[5] Limited by over-stabilisation effect
[6] Polyglycitol is an acceptable term in the USA for hydrogenated starch hydrolysates, but is not acceptable in Europe.

LNC characteristics, and may also warrant a reduced-calorie declaration. The food regulations of some countries consider the calorie load of erythritol to be the same as that of other polyols.

Calorie counting

When creating 'no-sugar-added' ice cream, a combination of maltodextrin (MDX) and polydextrose (PDX) is frequently used. MDX is produced by the partial hydrolysis of starch, and has the lowest cost of the bulking agents currently used in 'no-sugar-added' products. However, maltodextrin is a bad carb, which limits its usage where LNC status is required. As a result, polydextrose (a good carb) is the most common bulking agent in LNC ice creams.

PDX is a carbohydrate manufactured by the controlled polymerisation of dextrose. It does not contribute sweetness to frozen desserts. As with polyols, the reduced digestibility of PDX is associated with a low glycemic index and a laxative effect. Polydextrose, at one calorie per gram, makes the lowest calorie contribution of any of the major bulking agents. It also is useful because of its contribution to the fibre content of the final product.

Combating carbohydrates

The most recent development in the composition of LNC ice cream has been the introduction of maltitol syrup products. These syrups combine maltitol and polyglycitol components in a single ingredient. Certain types of maltitol syrup can be used as a direct replacement for the conventional ice cream sweetener system. Due to the high sweetness of maltitol and the water immobilisation properties of the polyglycitol component, there is no need to use additional bulking agents or high-intensity sweeteners. Using maltitol syrup has several advantages, including simplifying the logistics of inventory and ingredient assembly, and shortening the ingredient declaration, without changing the key characteristics that are expected in an LNC ice cream.

Milk protein concentrates (MPCs), derived from the ultra-filtration of skimmed milk, are dairy ingredients whose modified composition makes them suitable for application in LNC ice cream. If MPCs are subjected to a greater degree of filtration, their protein level increases and the level of lactose falls. This reduces the net carb level when MPCs are used to replace conventional MSNF. In addition, the higher levels of protein enhance the water immobilisation characteristics of the ice cream. However, MPCs do have their limitations, such as a high cost that increases with protein level, high viscosity associated with higher protein levels and regulatory restrictions.

Creamy and rich

When water immobilisation is reduced in LNC ice cream, the desirable properties (such as the control of ice crystal growth and eating quality) suffer. Stabiliser and emulsifier ingredients play an essential role in compensating for these effects.

The widespread use of microcrystalline cellulose (MCC) stabiliser systems in NSA and LNC ice cream is a testament to the efficacy of colloids in frozen desserts. The over-stabilisation threshold of MCC is higher than other commonly used colloids. MCC also contributes to creaminess through its function as a foam stabiliser.

The availability of such a wide range of alternative sweetening systems, bulking agents, and stabiliser/emulsifier systems bodes well for the carbohydrate-conscious consumer, as it will soon be possible to produce LNC ice cream without compromising taste or quality. This should ensure that ice cream manufacturers are equipped to compete in a changing market if the current consumer tendency towards cutting carbohydrates continues. ●