Lactose: the forgotten sugar

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Photos: Knechtel Laboratories, Inc.

The combination of lactose with whey protein concentrate (WPC) enhances this characteristic of the formula. This is especially valuable in milk chocolate.

We all know about sucrose, fructose and dextrose, but until recently lactose has been avoided or forgotten by many formulators and food manufacturers. So why is this the case?
In my opinion, this is due to lactose's:
a) unique solubility and crystallisation characteristics
b) metabolic sensitivity that affects many people (sometimes referred to as lactose intolerance).

As demand for specialised ingredients and products increases, the time has come to possibly re-evaluate the value of lactose for use in various confectionery, nutraceutical and bakery applications.

The way forward?

Recent research has shown that the unique characteristics associated with lactose can be beneficial to a product's formulation, in addition to being cost-effective. Although the issue of lactose intolerance needs to be taken into account, in many formulations its usage level is below accepted (published) consumer threshold levels[1].

In fact, lactose solubility and crystallisation characteristics may have a positive effect if used correctly. For example:

- lactose has limited sweetness. It is approximately 1/6th (16.7 per cent) as sweet as sucrose in solutions. Its use at various concentrations can be beneficial in reducing the overall sweetness profile of confectionery or can be used in other products with low sweetness and bulk solids.
- nutritionally, it is a very important sugar used in numerous infant food and nutritional products. It is used primarily because of its ability to promote the assimilation of calcium and phosphorous. Other findings indicate that it is a source of sugar matter in brain tissue.
- lactose is a reducing sugar, thereby enhancing colour and flavour generation in many bakery or confectionery formulations (Malliard and Streckler reactions).

Lactose and milk

Getting more specific and practical, recent studies have shown that lactose and various dairy powders, such as whey protein concentrate (WPC), non-fat milk (NFM), whole milk (WM), etc. have a synergistic effect on milky flavours. For example, the combination of lactose with WPC enhances this characteristic of the formula, permitting lower levels of concentration and enhancing possible cost savings. This is especially valuable in milk chocolate products, caramels and milk toffees.

Ingredient	Control	Substitute No.1	Substitute No.2
Chocolate liquor	25	25	25
Cocoa butter	14	14	14
WPC-34	16.8	16.8	12.7
Butterfat	7.2	7.2	7.2
Sucrose	36	26	31
Lactose	–	10	9.1
Lecithin	0.2	0.2	0.2
Vanillin	0.012	0.012	0.012

Table 1: Lactose substitution in milk chocolate compound coatings (per cent)

The examples in Table 1 demonstrate the potential uses of lactose in milk chocolate and compound coating formulations where:

Control: Sucrose reduction

Substitute No.1: 25 per cent of the WPC-34 dairy powder is replaced by lactose

Substitute No.2: 25 per cent of the WPC-34 dairy powder and 14 per cent of the sucrose is replaced by lactose

[Source: USDEC/Knechtel Laboratories (2004) and Association of Lactose Manufacturers (1990)]

It should be noted that the use of lactose in Substitute No.2 provided a two-fold benefit of enhancing the milk flavour and operating as a low-cost sugar substitute. Similar benefits can be seen in dark and white chocolate coatings or formulations (see Table 2).

Ingredient	Whole milk	Dark	White
Chocolate liquor	25	33	–
Cocoa butter	14	20	24
WPC-34	13	–	26
Butterfat	7.2	–	8
Sucrose	36	42	36
Lactose	5*	5*	5*
Lecithin	0.2	0.15	0.2
Vanillin	0.012	0.015	0.010

Table 2: Synergy with lactose formulations for various chocolate confectionery types (per cent)

** Where higher levels are possible*

[Source: USDEC/Knechtel Laboratories (2004) and Association of Lactose Manufacturers (1990)]

Lactose in cooked products

As hitherto mentioned, the use of lactose can be beneficial to cooked products. For example, its use in caramels, even at low levels, can frequently improve colour and flavour build-up whilst reducing cook time and increasing production efficiencies.

In regular, sucrose/glucose high-boiled hard candies, I now frequently recommend adding some lactose to the formulation at concentrations of 1–3 per cent to assist in reducing the candy's hydroscopicity and its adherence to the wrapper.

Even in sugar fondants or confectionery creams, lactose use (at various concentrations) helps retard sucrose crystal growth and its associated negative grittiness. It also results in a product that has a smooth, creamy texture and possesses a longer shelf life.

Other potential uses

Are there other potential uses for lactose in confectionery? Table 3 provides some useful insights and guidance on concentrations:

Note: Due to lactose's solubility, extreme care should be taken in all formulations to ensure total solubility or that the correct lactose particle size is used in crystalline systems.

[Source: Association of Lactose Manufacturers (1988)]

Confectionery type	Lactose concentration (per cent)
Pectin jellies	10
Liquorice	5–10
Wine gums	<10
Starch-based pastilles	10
Marshmallows	10
Ungrained nougat	15–20
Pulled chews	10–15
Chewing gum	15
Fondants	20
Marzipan	25
Fudge	25
Tableted lozenges	35

Table 3: Limitations on the use of lactose as sucrose replacements in confectionery

Concluding remarks

Lactose reduces the hydroscopicity of hard candy

I will leave the reasoning behind the positive aspects of lactose to the scientists. Is its crystallisation benefits (both retarding and/or initiating) related to its solubility? Are they related to the number of crystal forms it can have, each with its own somewhat unique characteristics or the size of crystals that are formed? Maybe it is related to the energy associated with crystallisation of multiple sugars? I am not sure, but for most of us, what matters most is that its usage can make better products.

Lactose is a very interesting sugar/ingredient and, if used correctly, many formulations can benefit from its use. However, as with other ingredients, it is important to be aware of its characteristics in order to design formulations and procedures with these in mind.■

Reference:
1 KLEIN, R., SWAGERTY, D. and SWAGERTY, D. The amount of ingested lactose required to produce symptoms is usually about 12–18 grams of Lactose, American Family Physician, *1 May 2002.*
"A typical Milk Chocolate bar (1.5 ounces or 42.5 gram) contains approximately 12% Dry Whole Milk, which would yield 2.8 grams of Lactose. So a consumer would have to eat four+ bars before any symptoms would be seen."

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