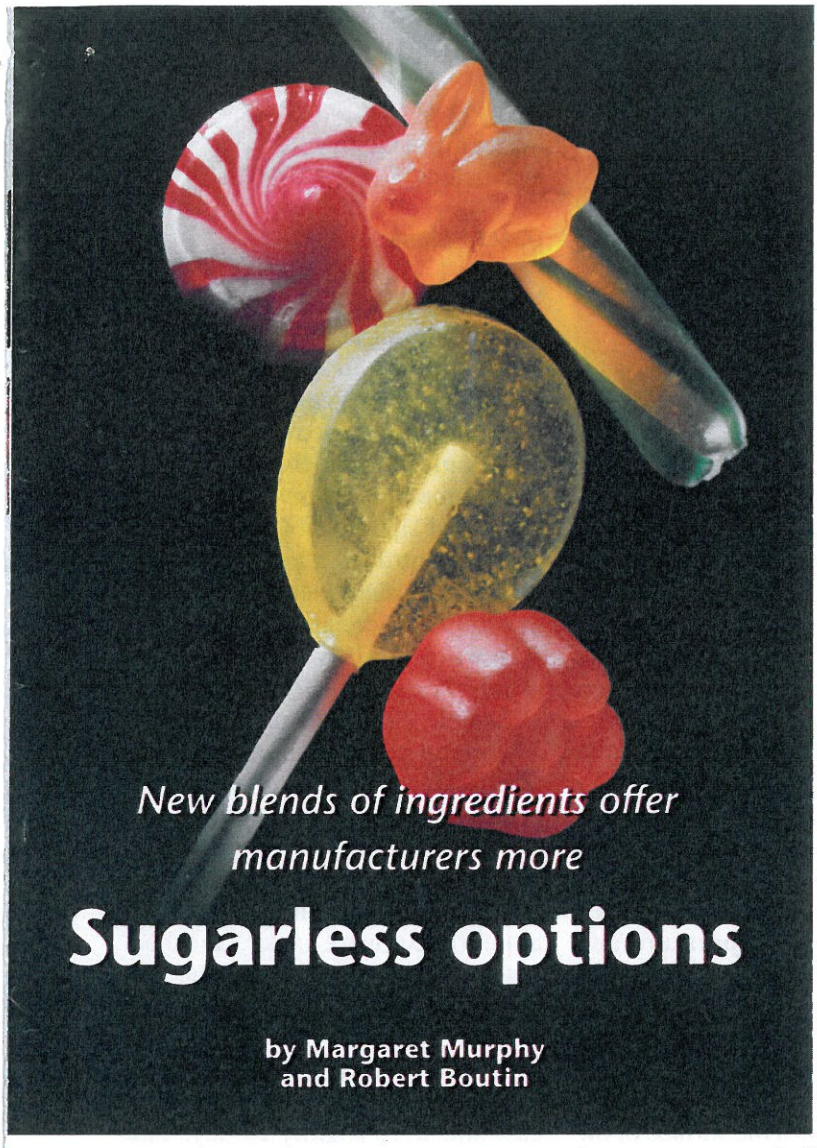


New blends of ingredients offer manufacturers more

Sugarless options

by Margaret Murphy
and Robert Boutin

As markets and consumer interests change, so do the products they purchase. This is especially true for sugarless hard candies that now, in just a few years, have grown to be a sizeable portion in the confectionery marketplace.

With this proliferation of sugarless products, product stability, producibility and ingredient costings continue to be of major importance to the manufacturers. These concerns have generated product and ingredient changes, especially in the hard candy market. For example:

- The use of early or more basic sugarless ingredients (sorbitol, mannitol) has mostly disappeared (in hard candy) because of its related processing difficulties (the need for starch depositing or polyethylene moulds) and instabilities;
- Second generation sugarless ingredients (polydextrose, HSH/maltitol type syrups) have significantly improved production ease, but these ingredients' hygroscopicity moderated their usefulness resulting in the final candies being unstable.
- With the availability of new third generation polyol ingredients (lactitol, erythritol, isomalt and the various new carbohydrate blended HSH/maltitol syrups) the production of numerous products with improved quality issues, as well as stabilities, can be accomplished.

Before the availability of these third generation products, manufacturers quickly accepted isomalt as the key ingredient for a majority of current sugarless hard candy products even though certain ingredient attributes were less than desired (ie: low solubilities, low sweetness, brittleness, high processing temperatures and most importantly, high costs). Using isomalt, production was easy with the resulting product relatively stable.

Now with these new ingredients, Knechtel undertook an in-house study evaluating the various hard candy polyol/sugarless ingredients and their blends (all formulations to be processable on current high speed hard candy equipment) as alternative matrix systems.

Ideally new blends of ingredients with improved characteristics could be identified. Since product stability is a major characteristic (many of the other attributes can be formulated around or adjusted; ie: addition of high intensity sweeteners) a thorough stability program was proposed evaluating each formulation at two temperatures/humidity conditions (70° F/50 percent RH & 70° F/50 percent RH).

While stability was our major interest, other production attributes were also to be noted, including cooking temperatures, final Karl Fisher moistures, color/clarity, brittleness, solubility and foaming.

Ingredients were selected from all major suppliers - Lonza, Roquette, SPI, Palatinit, Purac and Cultor. Specific syrups represented were:

- Syrup A: Lonza Hystar 5875, Roquette Lycasin 80/55;
- Syrup B: Lonza Hystar 3375;
- Syrup C: Lonza Hystar 6075, Roquette Polysorb RA-1000.

To supply the control to this study, a regular 60/40 (sugar/42 DE corn syrup) hard candy was used.

In all formulations, citric acid monohydrate was added along with a trace level of silicon oil to control foaming during the vacuum portion of the cook (sugarless batches also contained Acesulfame-K for sweetening). All in all, 24 different formulations were produced and evaluated (23 sugarless, one sugar control). One formula was included meeting the 50 percent reduced calorie claim.

To simplify this report, we have combined HSH/maltitol syrup data to mean the following relative polyol distributions (**Table 1**). This combination

TABLE 1

Polyol Distribution Ranges of Syrups

	SYRUP A	SYRUP B	SYRUP C
DP-1	5-9	13-17	12-15
DP-2	51-63	17-23	7-12
DP-3	14-19	9-13	8-12
DP-4 and higher	17-24	51-56	65-70

allowed grouping together similar data generated from the various manufacturers.

As stated previously, approximately 24-26 batches of product were created. In all cases, the following ingredient ratios were followed:

- Silicon oil (Myvacet 9-45): Trace
- Citric acid (monohydrate): 0.54%
- Acesulfame-K (Sunette): 0.10%

Typical formulations

HARD CANDY CONTROL	LBS
Granulated sugar	30.0
42 DE corn syrup	24.69
Citric acid	0.27
Myvacet 9-45	0.04 grams
Water	15.0

ISOMALT CONTROL	LBS
Isomalt	50.0
Water	16.7
Citric acid	0.27
Myvacet	0.04 grams

50% REDUCED CALORIE EXPERIMENTAL	LBS
Syrup C	16.67
Lactitol	26.3
Polydextrose	12.5
Citric acid	0.27
Myvacet	0.04 grams
Water	11.2

HSH/MALTITOL SYRUP (A, B AND/OR C) EXPERIMENTALS	LBS
HSH/maltitol syrup	66.67
Citric acid	0.27
Myvacet	0.04 grams

Test sample manufacture

Typical pilot plant hard candy manufacturing protocols were used. For all batches, the ingredients were weighed out, and preheated over a gas flame while mixing with a paddle until well blended. For the batch containing polydextrose, the polydextrose was dry blended with the lactitol before adding to the HSH/maltitol syrup and the water.

The mixture was then transferred to the Hansella/Bosch steam vacuum cooker. Each batch was cooked to the specific temperature and then released into the vacuum chamber.

A vacuum was applied to the batch for seven minutes. After vacuuming, the high solids batch was then poured onto the surface of the cooled water jacketed table that had previously been wiped with mineral oil to prevent sticking.

The citric acid and Acesulfame-K were combined and sprinkled onto the surface of the cooked mass and mixed in by turning the edges of the mass inward towards the center as it cooled to uniformly temper to a processable temperature. The mass was cut into chunks and run through the drop rollers.

The formed pieces were allowed to sit on the cooling table for about 30 seconds, and were then turned over to cool the top side and prevent flattening.

The candies were immediately placed into polypropylene bags and stored in larger polypropylene bags containing desiccant packets to prevent moisture pickup.

Samples were taken at this point for moisture analysis, stability studies and sensory evaluations.

Observations

Sample 1 - Isomalt control - This sample cooked up very watery. The citric acid and the Ace-K melted in easily. The cooked syrup was easy to work with and went through the drop rollers nicely. The finished pieces were a medium yellow color, were shiny and slightly cloudy. After 30 days in controlled atmosphere cabinets, the finished pieces had a dull, dry appearance, and held at 70% RH were slightly less dull and cloudy than those held at 50% RH.

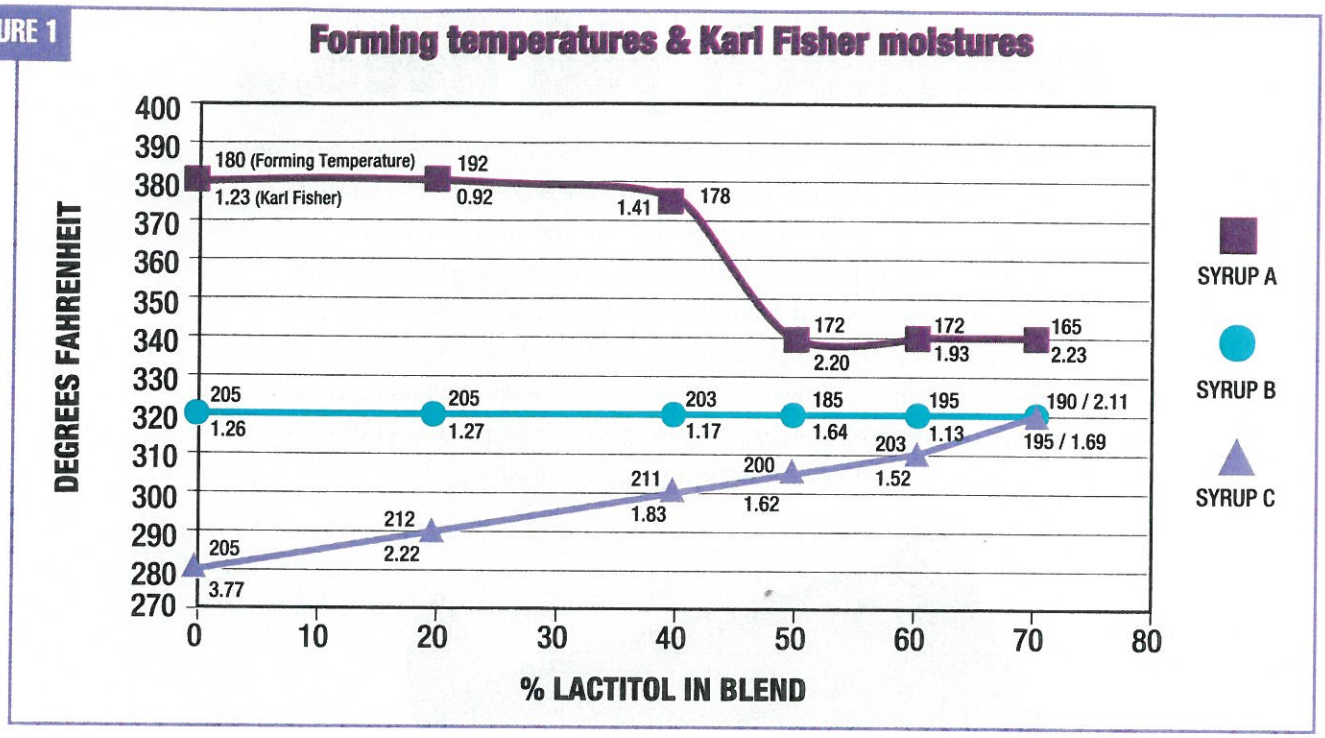
Sample 2 - Hard candy control - The syrup cooked up and formed nicely. The cooked syrup was fairly dry and stiff, with a dark yellow color. The finished pieces were slightly sticky and fairly clear. After 30 days, the finished pieces had a shiny wet appearance, were tacky, and had flattened out but not yet melted.

Sample 3 - Syrup A control - The cooked syrup was thin out of the cooker. The mass formed okay. The finished pieces had a pale yellow cast and were slightly cloudy. The pieces were shiny and sticky. After 30 days, the pieces were wet, shiny, and sticky, and had melted down to slightly over half their original size.

Sample 4 Syrup A @ 80%, lactitol @ 20%; Sample 5 Syrup A @ 60%, lactitol @ 40% - These cooked syrups were very thin and fluid. The finished pieces were a pale yellow color, and as the percentage of lactitol increased, became more cloudy. The pieces with a higher level of lactitol were less melted after being held 30 days.

Sample 6 Syrup B control - The forming temperature was high, but the pieces still had a tendency to crack. The finished pieces were white, clear and shiny, with a slight stickness. After 30 days, the pieces had a shiny, wet appearance and were sticky and clear. Those held at 70% RH were melting, but the pieces held at 50% RH were flat-

FIGURE 1

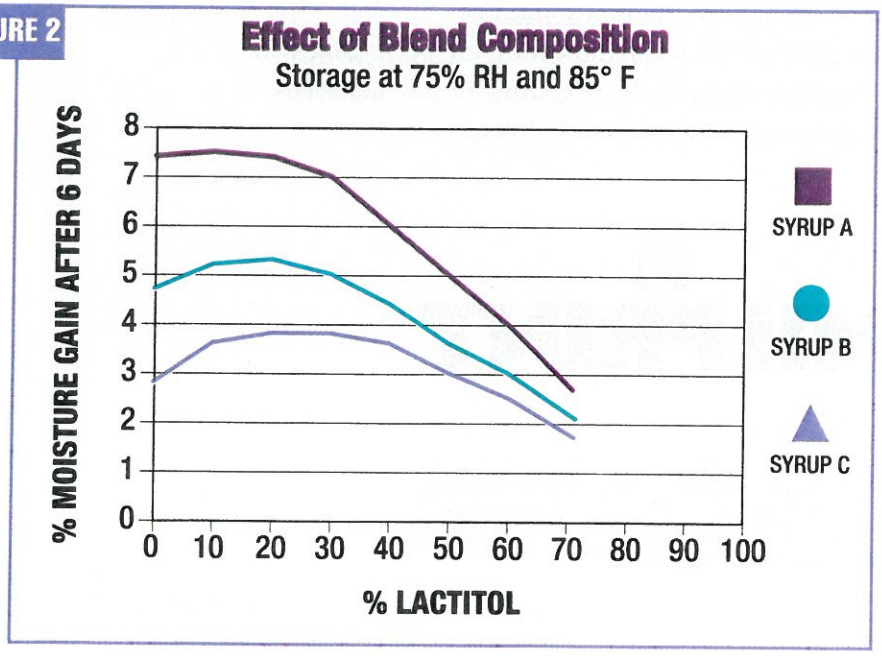


tened but not melted.

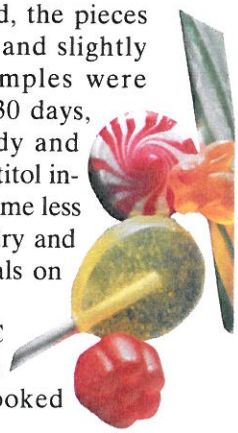
Sample 7 Syrup B @ 80%, lactitol @ 20%; Sample 8 Syrup B @ 60%, lactitol @ 40%; Sample 9 Syrup B @ 50%, lactitol @ 50%; Sample 10 Syrup B @ 80%, lactitol @ 60%; Sample 11 Syrup B @ 30%, lactitol @ 70% - The cooked syrups were very thick and viscous at higher levels of syrup B. As the level of lactitol in the formulations increased, the viscosity of the cooked syrups decreased. The finished pieces formed easily and had good standup. The finished pieces were white, clear and slightly sticky. After 30 days, the pieces had melted slightly and had become opaque. The samples with higher levels of lactitol were less sticky than those with lower levels.

Sample 12 Syrup C @ 100% - The cooked syrup was foamy under vacuum and very viscous out of the cooker. The finished pieces were white and cloudy with a lot of air bubbles, and felt sticky. After 30 days, they were shiny, almost glassy looking. The tops of the pieces felt dry, but the bottoms felt sticky. The pieces held at 50% RH were slightly flattened and those held at 70% RH were very flattened.

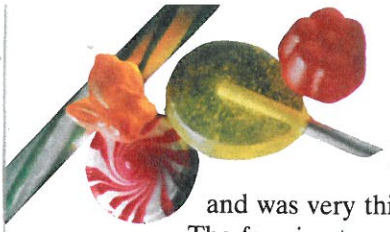
FIGURE 2



Sample 13 Syrup C @ 80%, lactitol @ 20%; Sample 15 Syrup C @ 50%, lactitol @ 50%; Sample 16 Syrup C @ 40%, lactitol @ 60%; Sample 17 Syrup C @ 30%, lactitol @ 70% - The viscosity of the cooked syrups was very similar to that of the hard candy control, and formed well. As the level of lactitol in the formulations increased, the pieces became more yellow and slightly more cloudy. All samples were slightly sticky. After 30 days, the pieces were cloudy and dull. As the level of lactitol increased, the pieces became less sticky. Sample 17 felt dry and had large visible crystals on the surface.



Sample 14 Syrup C @ 60%, lactitol @ 40% - The cooked syrup looked



dry out of the cooker, and was very thick and stiff. The forming temperature was high. The finished pieces were very clear, white and shiny. The pieces felt slightly sticky to the touch. After 30 days, the pieces were very cloudy with the sample being held at 70% RH being almost opaque, with a dull shine and a very sticky feel.

Sample 18 Syrup C @ 25%, litesse II @ 25%, lactitol @ 50% - The cooked syrup was thick, stiff and dry out of the cooker, but was sticky during forming. The finished pieces were yellow and slightly cloudy, shiny and slightly sticky. After 30 days, the pieces were cloudy and almost opaque with a dull shine, were slightly sticky with some melting.

Processing issues

The level of lactitol used in the various formulations presented different affects on the processing of the batches of hard candy that were produced with HSH/maltitol syrup.

In formulations made with syrup A, as the amount of lactitol in the batch increased, the cook temperatures decreased. However, with the lower cook temperatures, the batches' residual moisture were up to 1.0 percent higher than batches processed at higher temperatures (**Figure 1**).

In the series of hard candies made with syrup B, the cooking temperatures of the batches remained constant regardless of lactitol levels used.

The forming temperature of the pieces decreased as the usage level of lactitol increased. The moisture in the finished pieces remained constant, as measured by Karl Fisher titration (Figure 1).

As the level of lactitol increased in the formulations made with syrup C, the cook temperature increased as well. The forming temperature of the pieces fluctuated but did not seem to be influenced by the level of lactitol in the batch.

As the level of lactitol used and the cook temperature of each batch in the series increased, the moisture levels of the finished candies decreased (Figure 1).

Questions of stability

In the eight day stability study, samples containing various blends of the HSH/maltitol syrups and lactitol were held at 85° F and 75 percent RH. For each HSH/maltitol syrup series, moisture gain peaked when the lactitol in the formulation was between levels of 20-30 percent, and then decreased as the percentages of lactitol increased.

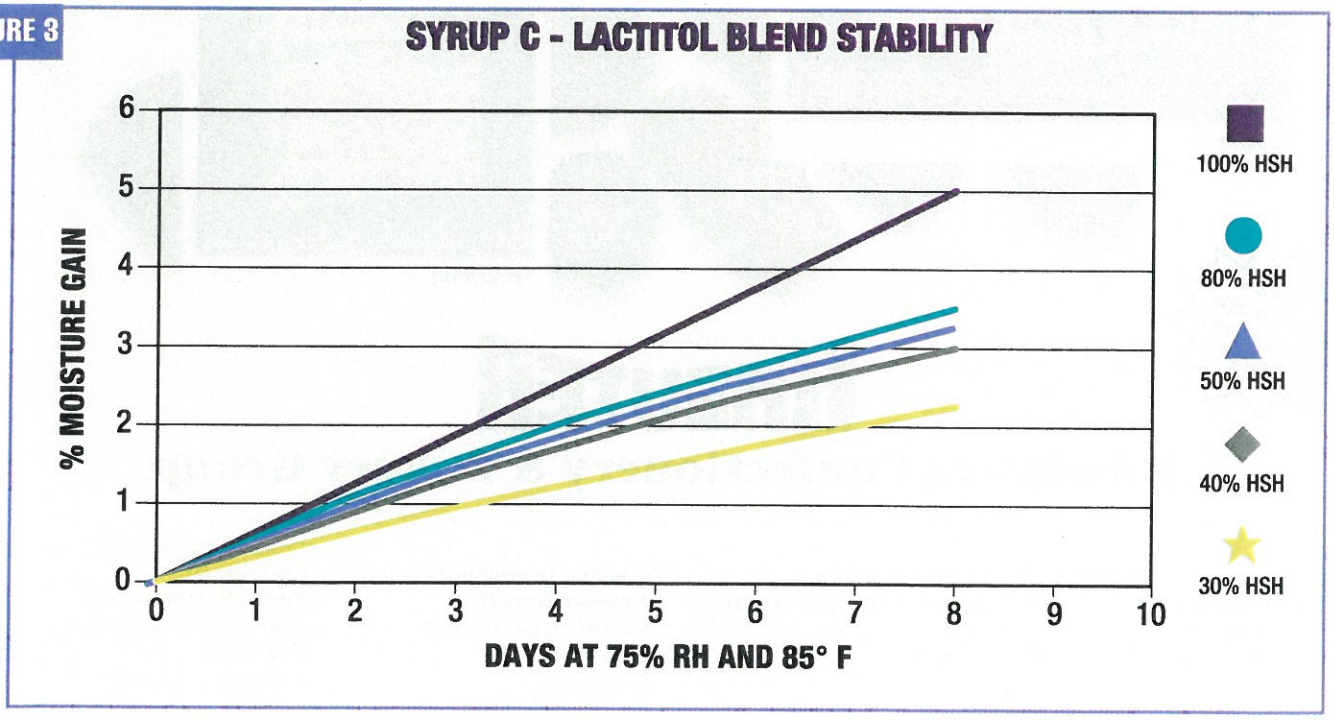
As in the 14 day stability test, held at 70 percent RH, the samples containing syrup C and lactitol picked up the least amount of moisture, while the samples containing syrup A and lactitol picked up the most moisture (**Figures 2** & **3**).

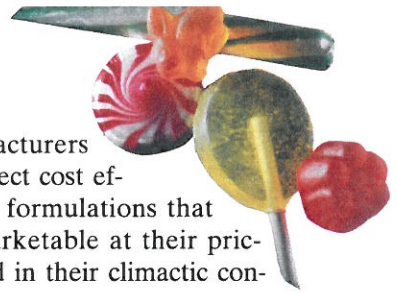
When compared to the other samples in this study, the sample containing syrup C and lactitol at 40 percent had a moisture pick up less than the hard candy control.

The isomalt control sample picked up the least moisture of all samples in the study, while the 50 percent reduced calorie sample (containing 25 percent polydextrose, 25 percent syrup C and 50 percent lactitol) picked up slightly less moisture than the 60:40 syrup C and lactitol blends (**Figures 4** & **5**).

The amount of lactitol in the blends affected most of the sensory attributes of each HSH/maltitol series similarly. As the percentage of lactitol increased, the color of the

FIGURE 3





finished pieces became darker, the pieces became more clear, and the brittleness of the piece increased. As the level of lactitol increased, the sweetness release increased in the syrup C and syrup A series, but decreased in the syrup B series.

The moisture of the finished pieces, as measured by Karl Fisher titration was affected by the level of lactitol in the formulations. As the level of lactitol was increased, the moisture in the syrup A and B series increased.

The moisture in the syrup C series decreased as the level of lactitol increased. However, at levels of up to 40 percent lactitol in the syrup C series, the moisture was higher than those in the syrup A and B series (Figure 6).

In the 14-day stability studies, the effect of blend composition affected each of the HSH/maltitol series similarly.

In the samples held at 70 percent RH and 70° F, the moisture gain peaked at 20-40 percent lactitol and then decreased as the level of lactitol increased to 70 percent.

All of the HSH/maltitol syrup samples containing 70 percent lactitol had gained approximately 0.75 percent moisture, as compared to a range of 0.90-1.80 percent moisture pick-up at 20 percent lactitol in the blends (Figure 6).

The syrup C sample containing lactitol at a 70 percent level picked up less moisture when held at 70 percent RH than all other samples, except for the isomalt control.

When held at 50 percent RH and 70° F, the syrup C sample containing 70 percent lactitol picked up less moisture than the other sample, quite similar to the isomalt control.

Conclusions

A review of this data and study establishes the facts that various sugarless formulations can be generated and produced (by varying ingredients and usage levels) with stabilities better or worse than hard candy controls.

By proper selection of these ingredients and processing conditions, manufacturers can select cost effective formulations that are marketable at their pricing and in their climactic conditions.

The use of lactitol appears to be promising in the production of sugarless hard candies. Its use in various sugarless hard candy formulations has been proven to affect the processing, moisture pick-up (hygroscopicity), stability, costs and sensory characteristics.

The use of lactitol along with type C HSH syrups in sugarless hard candies effectively reduced the moisture in the final product, as well as moisture pick-up over time (ie: increases stability and reduces the candies' hygroscopicity).

The clarity, sweetness release and brittleness of the finished pieces were also positively affected by the use of this lactitol and type C HSH syrup blends.

Note, processability of the sugarless hard candies made with type C HSH syrup blend was found to im-

FIGURE 4

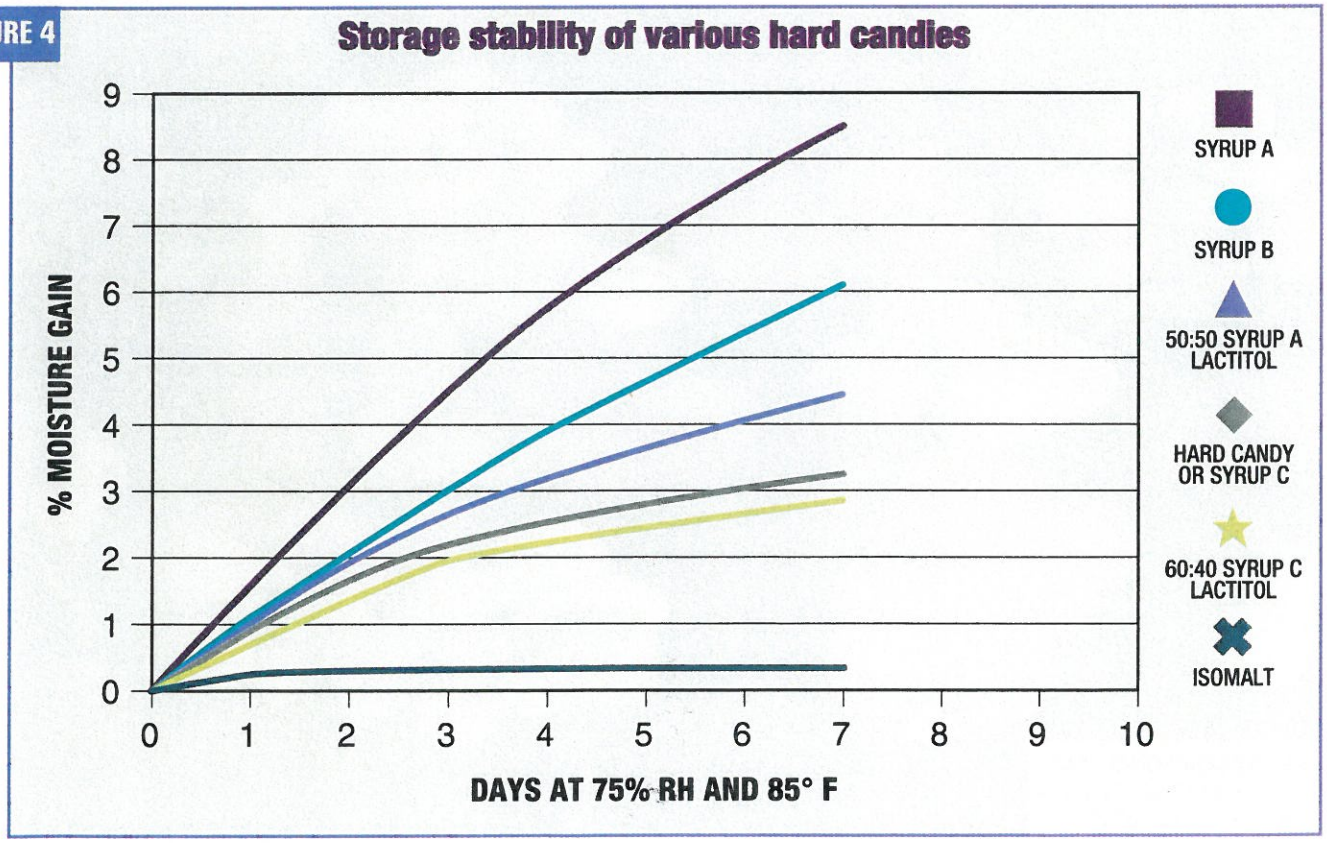
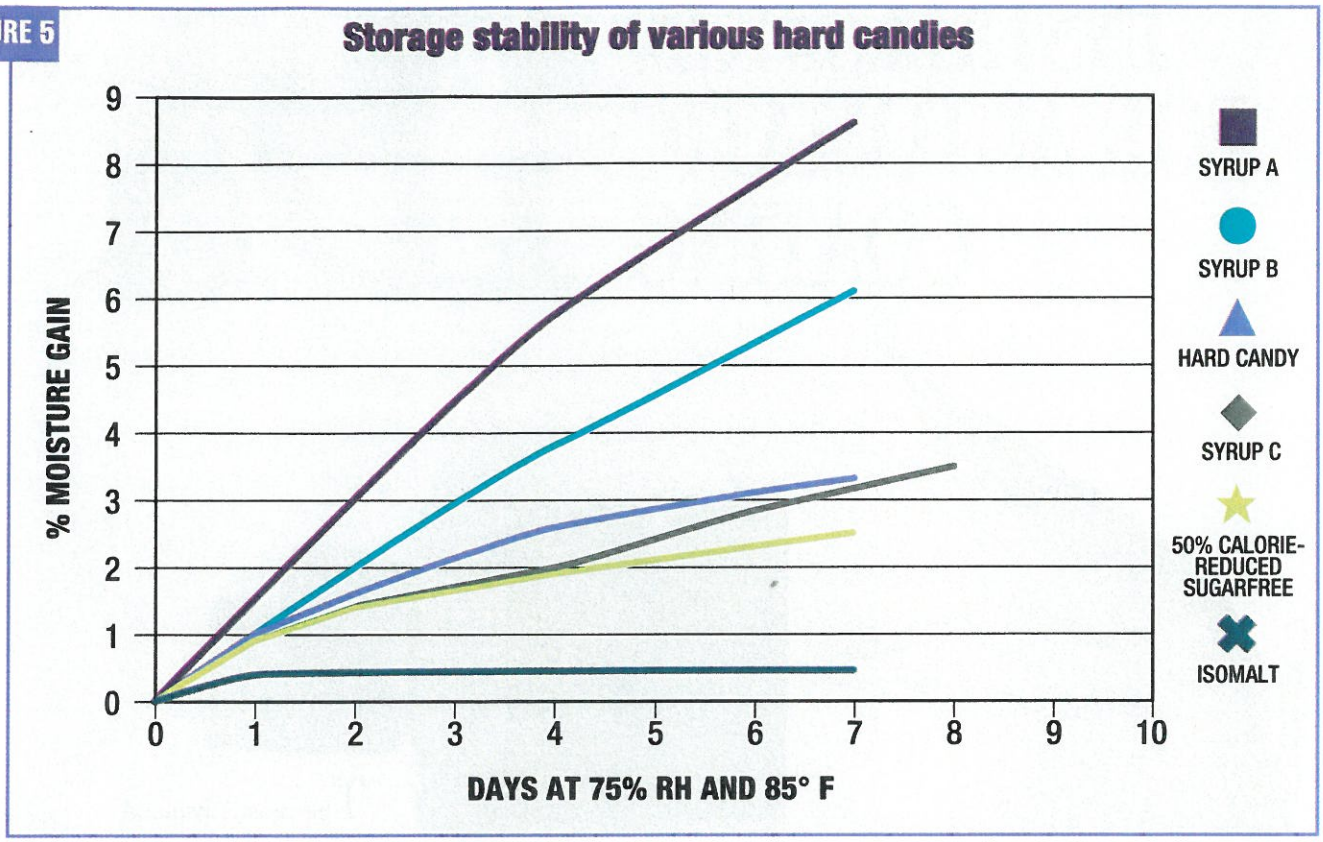


FIGURE 5



prove as the percentage of lactitol in the blend formulation increased. Alone, type C HSH syrups, are generally too viscous (foamy) to process on continuous vacuum cookers, but with care, they can be processed on batch type units.

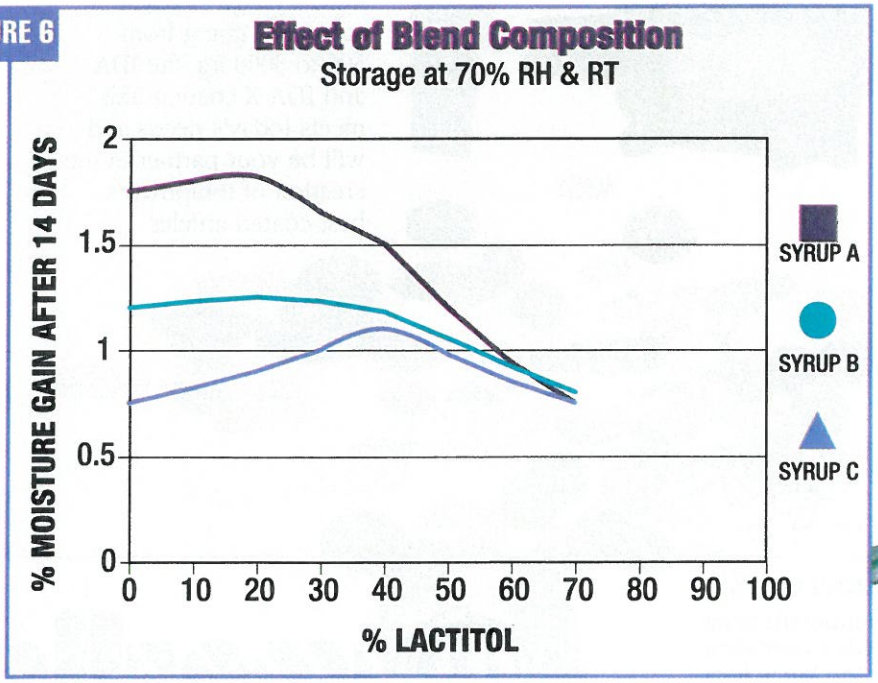
What's next?

Data processing continues, with further insight as to the reasons for each formulation's actions being sought. It is logical to assume that the carbohydrate profiles of each specific formulation plays an important role in its processability as well as its final stability.

With time, hopefully these conclusions can be drawn.

Hopefully this review will allow further improvements in the formulation of sugarless hard candies, as well as show applications in other sugarless products (ie: caramels, toffees). □

FIGURE 6



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Knechtel, with 43 years of service, and a facility of more than 27,000 square feet, is one of the oldest and largest confectionery consultants worldwide. It offers services in a variety of areas including pharmaceutical, food, gum and engineering.