Sugarless Hard Panning

While panning is quite old, consumer demand and technology have pushed it to the forefront of our industry.

Robert Boutin, Akila T. Kannan, Jonathan Warner
Knechtel Laboratories

This paper will discuss sugarless panning from several different approaches:

- Basic principles of sugar and sugarless panning (similarities and differences)
- Sugarless panning fundamental methods
- Newer and more recent advanced techniques

In every report there has to be a basis of understanding and a starting point. We will be using sucrose and its sugar panning technique as basic references.

As for those who are saying, why is he talking about sucrose and sugar crystallization when his paper is on sugarless panning, let me say that many similarities exist in both products' theory and application (though conditions are uniquely different for both), and, therefore, background knowledge can be gained.

Several important sugar or crystallization generalities that I find helpful in understanding or designing my panning experiments follow:

- Velocity of crystallization — the velocity of crystallization of a 95 percent pure sucrose solution is about 50 percent of that of a pure solution.
- Viscosity — the viscosity of a syrup does not prevent sucrose crystallization, but it does retard its velocity.

A syrup's purity and viscosity (at a temperature) are two key parameters in successful panning, especially sugarless.

BACKGROUND ON SUGAR AND SUGARLESS PANNING

What is panning? Panning is the continuous application of sugar or sugarless sweeteners in a solution to create a shell on the outside of candy. A hard shell forms on the candy from crystallization of the sugar or sweetener by evaporation of the water from the solution that is added. The solution can be applied hot or cold depending upon the product's temperature sensitivity. Usually, this evaporation is accelerated by hot or cold air blown over the surface of the candies. To compound the formation of a shell, the candies are tumbled in a revolving pan during this process to create a smooth, shiny surface and a hard, crunchy shell. Some examples of hard-panned candies are gumballs, Jordan almonds, jawbreakers, gum chiclets and coated chocolate lentils.

Soft-panned candies, like jelly beans, are formed by additions of liquid syrups (phases)

Boutin is the executive vice president and co-owner of Knechtel Laboratories. He has more than 30 years' experience in the confectionery industry.

Robert Boutin

There are technologists who say that panning, with sugar or sugarless ingredients, is an art, while others say it is a science.

and dry powder applications on top of the rotating center. In this panning technique, the crystal phase only partially crystallizes in or on the liquid phase, thus producing a coating of which the hardness is determined by the ratios of liquid to crystal phases.

These techniques can be used to produce sugar and sugarless products. Sugarless is quite similar to sugar panning, but uses sugarless sweeteners, such as sorbitol, isomalt, xylitol, maltitol or lactitol, among others, to replace traditional sucrose.

We mentioned both hard and soft panning, but in the interest of keeping this paper focused we will limit its scope to hard panning.

Before progressing much further, let me comment that there are technologists who say that panning, with sugar or sugarless ingredients, is an art, while others say it is a science. I would like to offer another definition and build a little upon it. Jeff Bogusz of Ferrara Pan Candy said that panning is a sport, and to be good at it you need practice, practice and more practice. I would agree that panning, especially sugarless panning, is a sport, but more specifically it is the sport of golf. Because, like golf, you need to practice a lot to be good at it, but just when you think you've got it mastered, it proves to you how little you know.

Before getting sugarless specific, let's discuss the importance of syrup viscosities.

Solubility of Polyols

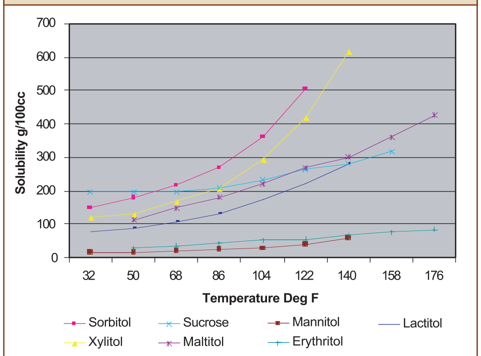

Figure 1

Viscosity of Saturated Solutions

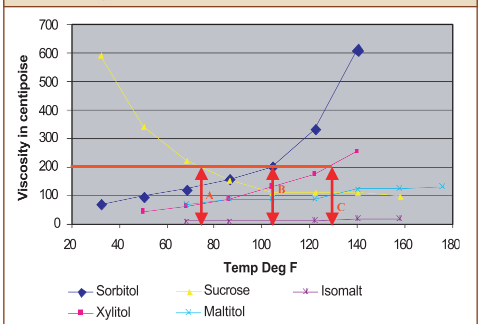

Figure 2

Syrup Viscosity

From previous experimentation (mostly associated with sucrose and dextrose), syrup viscosities in the range of less than 200 centipoise (CPS) at a given temperature produce acceptable syrup distribution and crystallization results. This remains true for the sugarless ingredients also.

While lower viscosities can be used, the added moisture usually lengthens the panning cycle and reduces efficiency, while higher viscosities cause surface irregularities and/or extended panning cycles (see Figures 1 and 2).

As you can see from Figure 2, the 200 CPS number is around 75ºF for sucrose, around 100ºF for sorbitol and around 127ºF for xylitol. (*Note:* All data is at a given fixed solids).

What one needs to realize is that the 75ºF number is the minimum temperature for panning with a 70 percent solids sucrose solution, while 100ºF and 127ºF are the maximum syrup viscosity temperatures for sorbitol and xylitol respectively. And, unlike sucrose, additional heat for the polyols does not lower viscosity, but rather raises it.

Because of these differences, it is generally assumed that sugarless panning is more difficult to accomplish than its sugared counterpart, usually requiring tighter processing controls and parameters. This is somewhat true and is regardless of which type of ingredient or panning equipment is used. Logically, the more automated the panning unit, the easier sugarless panning will be. But, with a little care, even the older open pans can be efficiently utilized.

SORBITOL

Sorbitol Hard Panning

Sorbitol is a polymorphous substance and three crystalline forms have been established.

The gamma form is the most stable, possessing the highest cooling effect and lowest hygroscopicity. For successful panning, it is imperative that the coating conditions selected allow the formation of this gamma crystal form.

As stated earlier in this paper, one must realize that in establishing these coating conditions, the crystallization and evaporation of the sorbitol is controlled by the syrup viscosities and coating bed temperatures.

Depending upon the substrates being panned (i.e., gum dragees, chocolates, pressed dragees), syrup temperature and viscosity are selected so that the syrup's viscosity does not retard crystallization and that excess water is lessened.

Again, let me reiterate that sorbitol panning is not significantly different than sucrose sugar panning, except that certain parameters are unique.

Ideally, for sorbitol panning, I generally recommend that a 70 percent high-purity solution be used and applied at temperatures between 85°–100ºF (see Figure 3).

Sorbitol is especially sensitive to contaminants (HSH, HGS, mannitol, sucrose, etc.) and even more than sucrose, syrup purity is very important (small traces of mannitol can create major panning difficulties).

Levels of mannitol as low as 0.5 percent can significantly affect panning efficiencies. At 2 to 3 percent levels, crystallization can be halted or stopped.

Maltitol

Maltitol seems to have properties and panning characteristics similar to sorbitol, as well as its disaccharide cousin sucrose.

It can be used, and is used currently, by many companies as the hard-panned coating ingredient of choice.

Like sorbitol, maltitol's purity is key to some of its panning success. Purity levels of at least 96 percent or more are needed for panning success, especially in solution panning.

Panning parameters for maltitol are seen in Figure 4.

Xylitol

Xylitol's sweetness profile, synergism with

Sorbitol panning is not significantly different than sucrose sugar panning, except that certain parameters are unique.

Sorbitol Panning Parameters

Bed Temperature	75°F
Inlet Temperature	75°F
Inlet Air Humidity	50% rh
Inlet Air Flow	1,200 CFM applied after 1 minute of free tumble
Syrup Concentration	70% solids
Syrup Temperature	85°–100°F
Syrup Application Rate	7–10 minutes (do not overdry samples between syrup application. Excess drying will cause coating brittleness and chipping)
Application Quantity	75–100 cc

Figure 3

Maltitol Panning Parameters

Bed Temperature	70°–100°F
Inlet Temperature	70°–100°F
Air Relative Humidity	< 50% rh
Inlet Air Flow	400–1,250 CFM applied after 1 minute of free tumbling and syrup distribution
Syrup Concentration	60% ± 5%
Syrup Temperature	110°–150°F
Syrup Application Rate	3–5 minutes

Figure 4

Xylitol is one of the easiest polyols to crystallize and due to this characteristic the use of high heat or elevated temperature should be used cautiously.

other polyols, dental claims and lower hygroscopicity make it interesting to the consumer and manufacturers.

I should note here also that xylitol is one of the easiest polyols to crystallize and due to this characteristic the use of high heat or elevated temperature should be used cautiously. One can easily accelerate its crystallization to a point that unacceptable, noncrunchy, gritty, textured products can be formed, due to large crystal growth.

Just as with sorbitol panning, the processing parameters will be established by the product to be panned and its characteristics, i.e., heat stability.

For example, if we were to pan sugarless gum dragees, a bed temperature of 69° to 70ºF would be selected and maintained throughout the studies. With this established temperature, a saturated solution of xylitol (63% solids) was identified and successfully utilized. Syrup temperature was maintained at between 73°–75ºF and bed and air temperature were controlled at 68° to 70ºF. Relative humidity of inlet air was maintained at below 50 percent (Figure 5).

Lower syrup concentration (greater than 63%) for this specific bed temperature resulted in longer panning times, probably due to the extra time required to evaporate the added moisture. Higher syrup concentrations (less than 63%), again for this specific bed temperature, resulted in rough product surfaces (alligator skin).

The rationale for why the higher syrup concentration and higher syrup temperatures cause rough surface buildup is not exactly known. Theoretically, since its viscosity is below the 200 CPS deemed optimum for panning syrups, its use would seem viable.

Two thoughts have been proposed as possible causes: at the higher solids, we may be causing spontaneous crystallization; or at higher temperature, due to xylitol's increased solubility, we could be causing the re-solution of subsequent panned layers.

To combat these effects, many companies have added binders (i.e., gelatin) at greater than 1 percent levels to lessen or eliminate this problem. Also, the use of this "binder" has proven beneficial in the coating of pieces with sharp corners, significantly lessening chipping or wear-off (see Figure 6).

Isomalt

Another interesting sugarless ingredient or bulking agent is isomaltulose (commonly known as isomalt).

Xylitol Gum Dragee Panning

Bed Temperature	75°F (established by the temperature where product deformation begins)
Inlet Air Temperature	68°F
Inlet Air Humidity	>50% (ideally 40%)
Inlet Air Flow	1,200 CFM applied for 1 minute of syrup tumble
Syrup Concentration	63% solids
Syrup Temperature	73°–75°F
Syrup Application Rate	3–5 minutes (do not overdry samples between syrup application. Excess drying will cause coating brittleness and chipping)
Application Quantity	Approximately 30–40 ml

Figure 5

Xylitol Gum Dragee Panning No. 2

Bed Temperature	75°F (established by the temperature where product deformation begins)
Inlet Air Temperature	75°F
Inlet Air Humidity	>50% (ideally 40%)
Inlet Air Flow	1,200 CFM applied after 1 minute of syrup tumble
Syrup Concentration	About 68% solids (67% xylitol, 29 percent water, 4% of a 40% gum arabic solution)
Syrup Temperature	95°F
Syrup Application Rate	4–6 minutes (do not overdry samples between syrup application)
Application Quantity	Approximately 30–40 ml

Figure 6

Isomalt's low hygroscopicity, high purity and chemical stability make it an interesting ingredient for panning.

For panning, isomalt's solubility plays an important role, and somewhat complicates the identification of a viable panning technique.

By reviewing my earlier solubility data, one can see that because of isomalt's reduced solubility, elevated temperatures are required to form reasonable panning syrup concentrations (170°–180°F; 65–75% DS). This elevated syrup temperature becomes a problem when one is trying to coat heat-sensitive products, such as gum dragees (see Figure 7 for panning specifications).

Normal processing procedures are suggested for this application, with syrup being applied by ladle or spray.

Since isomalt crystallizes rapidly, care must be taken to prevent overdrying of the panned layer between syrup applications (quite similar to that seen in xylitol). If allowed to overdry, coating wear-off and chipping can become pronounced.

This problem can be controlled by careful attention to application rate and timing. Alternately, just as used in the other methods, the use of a plasticizer seems appropriate. I would suggest possibly adding 1 to 3 percent gum arabic to the syrup initially, or other ingredients (gelatin, HSH/HGS syrups, etc.) could prove beneficial.

The addition of these ingredients improves the processing ease, but will also lengthen the drying cycles. Their use at minimal levels is recommended.

Isomalt's low hygroscopicity, high purity and chemical stability make it an interesting ingredient for panning.

Isomalt Panning

Bed Temperature	70°–75°F
Inlet Air Temperature	70°–75°F
Inlet Air Humidity	45% rh
Inlet Air Flow	Approximately 1,200 CFM after 1 minute of free tumbling
Syrup Concentration	70% solids
Syrup Temperature	170°–175°F
Syrup Application Rate	4–5 minutes
Application Quantity	75–100 cc

Figure 7

Lactitol

While lactitol's availability, cost and laxative effect have limited some of its initial success, its more recent availability warrants its inclusion here.

A panning technique and parameters are found in Figure 8.

Lactitol Panning

Gum Solution Concentration	Precoat centers with typical gum arabic syrup 25–40% (may need to dry charge centers with powdered lactitol to prevent centers from sticking together)
Syrup Concentration	Pan with 63–65% solution
Syrup Temperature	80°–100°F
Inlet Air Humidity	Below 55%
Inlet Air Temperature	Drying air 95°–100°F
Inlet Air Flow	400–1,200 CFM

Note: Apply syrup, let distribute to all pieces (apply powdered if applicable). Apply warm dry air. Repeat cycles every 2–3 minutes. Do not overdry between applications and finish with a reduced solids syrup 60–61%.

Figure 8

ADDITIVE ISSUES

We've already talked a lot about syrup viscosity, but let me add a few more comments on panning syrup purity. While we have discussed the purity of the polyols that we are going to use, we frequently forget about the other additives (i.e., colors and flavors) used in panning syrups.

Colors added to syrup can frequently be seen as crystal initiators (especially titanium dioxide). Depending upon usage levels and polyol type they can accelerate crystallization to a point that the crystals generated are gritty in nature when later eaten, or, to a greater extreme, sometimes can cause spontaneous crystallization of ➤

Colors added to syrup can frequently be seen as crystal initiators and depending upon usage levels they can accelerate crystallization to a point that the crystals generated are gritty.

syrup in the holding tank. Alternately, if we are using color suspensions, one has to be cautious of the carrier used, making sure that it is the same, or at the very least a compatible, polyol. Also, these suspensions normally use gums as thickeners or suspending agents, and, as we have learned, viscosity can be a crystallization deterent.

Flavors can either be oil- or water-based and their presence can influence panning efficiencies.

One of the negative traits associated with sorbitol coating has been its resulting lack of crunch when compared to other polyols or even sucrose.

In-house research by one supplier has found that the crunch of the sorbitol coating (on a gum dragee) was directly related to the water activity of the substitute or gum (see Figure 9).

It would seem that where the water activity (A_W) of the center product was lower than that of the sorbitol, the coating turned soft and crunch was lost; but where the center product's water activity (A_W) was similar to or higher than the coating, the coating's crunch texture was maintained. While this work is older and was done on sorbitol coating, I would expect it to be consistent and similar for other polyols.

Basic Technology

The typical crystallization methods discussed, while applicable, were not really compatible to the production of confectionery products. Not only did we use an expensive ingredient, but panning speeds were inherently slow; the technologies required greater skills with more experienced operators and/or the use of expensive automated panning systems.

Needless to say, our industry is very resourceful and where there is a will, we usually will find a way. Sugarless panning was and is no exception.

Effect of A_W (Water Activity) on Texture of Panned Coating

Liquid Phase	A_W of Center	Texture: Coating*	Texture: Center*
Liquid Sorbitol (crystallizable) Neosorb 70/20	0.7	Hard	Brittle
Liquid Sorbitol (noncrystallizable) Neosorb 70/70	0.65	Hard	Brittle
HSH/HSG Syrup	0.55	Crunchy	Soft
Glycerine	0.35	Soft	Very Soft

* After 10 months
Note: A_W of crystalline sorbitol is 0.64

Figure 9 *Source: Roquette/Knechtel*

NEW APPROACHES

While advancements have been seen in all polyol technology, the two that are most interesting and useful to us now are those associated with maltitol and isomalt panning which are popular because of their particular attributes.

Isomalt's physical and chemical properties are quite similar to those of sucrose. Hence, it can be substituted for sugar in a formula and produced in existing facilities. Isomalt can be ground to a very fine particle size, which is necessary in the manufacturing of candy using new technologies. Isomalt has low hygroscopicity. For example, candies made with 100 percent isomalt (held at 20°C temperature and 63 percent relative humidity) show no water absorption, whereas when sucrose or corn syrup are used there is 15 percent (w/w) water absorption.

Maltitol has many positive attributes as well, one being that maltitol can be used for coatings because of its relative ease of crystallization. In addition, maltitol is as sweet as sugar and provides a very pure white coating without any added color. Maltitol is nonhygroscopic, retains crunchiness well and can be coated on centers with a range of water activity levels.

To capitalize on the potential of isomalt and maltitol, some new techniques were developed. ➤

There are many patents pertaining to these second-generation panning methods, all aimed at gaining the following sugarless panning attributes:

- They would be very fast and allow a considerable shortening in panning time, therefore increasing efficiency and/or equipment capacity.
- They would be simple to set up and use in commercial plants.
- They would produce very high-quality, nonsticky coated products, in which the appearance and texture would not change after significant periods of time.

Basically, two novel approaches are now being used:

A dry-charging approach, quite similar to that used in sugar panning, where high-purity polyol solutions are applied to the product and followed with an application of high-purity powdered polyol. This approach seems to be aimed at using the dry powders to seed the liquid application and accelerate both product weight gain and crystallization. Modifications of this technique have been used where various binder components have been added to the polyol syrup for enhanced adhesion (i.e., gelatin, gum arabic, etc.).

A suspension approach, where the panning syrup consists of a thickened, saturated polyol solution, various thickening and suspending agents, and additonal polyol fines held in suspension. Here the thickening and suspending agents not only retard crystallization of the syrup phase, but they also aid in keeping the undissolved polyol crystals suspended. Basically, here we are panning with a polyol saturated suspension.

DRY CHARGING TECHNIQUE

Pan using regular methodology, i.e., apply sufficient syrup to evenly coat all pieces. After distribution, add or dust with dry, very fine powdered isomalt (isomalt ST-PF is recommended). Distribute powder evenly onto all rotating pieces and add only enough to apply a thin coating on pieces. Repeat as necessary or desired. As target weight is approached, discontinue use of dry powder addition or dusting, applying syrup solely or possibly using reduced syrup solids (Figure 10).

SUSPENSION TECHNIQUE

Typical panning techniques are used. Depending upon the quality of the centers being initially panned, some powder applications may be required. Generally, after smoothing no further powder dusting is needed. Continue panning with increased suspension portions/phase until the desired final weight is neared. Final applications of reduced solids and smaller applications with minimal air are suggested to optimize surface smoothness (Figure 11).

While advancements have been seen in all polyol technology, the two that are most interesting and useful to us now are those associated with maltitol and isomalt panning.

Dry Charging Technique Formulation

Ingredients	%
Isomalt GS*	66.00
Water	29.80
Aspartame	0.05
Acesulfame K	0.05
Gum Arabic 50%	4.10
TiO_2	1.00
Total	100.00

*Isomalt GS and ST are interchangeable in most cases.
Note: Syrup and application temperatures are 110°F to 130°F.

Figure 10

Suspension Technique Formulation

Ingredients	%
Isomalt ST-M*	43.65
Water	29.00
Aspartame	0.05
Acesulfame K	0.05
Gum Arabic 50%	4.10
Isomalt ST-PF*	22.15
TiO_2	1.00
Total	100.00

*Isomalt GS and ST are interchangeable in most cases.
Note: Syrup and application temperatures are 120°F to 140°F.

Figure 11

While panning is quite old, consumer demand and technology have pushed it to the forefront of our industry.

Before leaving this section, let me note and emphasize here, again, that numerous patents have been issued on the use of these newer technologies or techniques. Before using, I suggest a review of existing patents or conversations with your suppliers as to their availability.

While I highlighted isomalt in these formulations, I believe, as stated before, that similar techniques or approaches are available for other polyols, especially maltitol. But again, please check patents or your suppliers regarding usability.

Even though these techniques are novel, the viscosity of the syrups being applied to the candies remain around the established 200 CPS viscosity range, adjusted by the addition of thickeners or binders to the basic syrup solution.

FUTURE

After looking at past and present technologies, let us turn our attention towards the future.

While panning is quite old, consumer demand and technology have pushed it to the forefront of our industry. This expansion will continue to necessitate changes and growth. To me it would seem that these changes and advancements will come in both the equipment as well as the ingredient sectors. These changes will bring about further changes in both current equipment and technology, as well as future ideas.

Equipment

I continue to see the growth of automated computer pans in our industry, be it perforated pans or belt coaters. While requiring capital investments, their use in panning (sugar and sugarless) will continue to grow.

Not only do I foresee the continued proliferation of existing technology in automated pans, newer panning systems specifically designed to meet our sugarless panning needs will be offered. These systems may be as simple as improved powder dosing units or as complex as continuous flow-thru designs.

Equipment possibilities may expand to fluid bed, flow-thru or spin coaters, where recent experiments seem to show promise. Alternately, new equipment/technologies could replace the panning operation completely on some products. Possibly co-extrusion technology could work, where we would combine a center and microthin extruded outer shell (which subsequently crystallizes or grains). Is this far-fetched? Maybe. But probably something similar was said about automated computer pans years ago.

Ingredients

Ingredient characteristics will dictate the design and development of novel technologies or methodologies. One ingredient to look for is tagatose. It is a nonhygroscopic monosaccharide with 1.5 kcal/g. It does not promote tooth decay, has little glycemic effect and is prebiotic. Natural claims with tagatose can be made as well. One other thing to note about tagatose is that it goes through Maillard browning, so facilities must be prepared to accommodate caramelization. I am sure there are other ingredients on the horizon; only time will tell if these new ingredients' cost, availability and usefulness will allow them to be in our chest of formulating food tools. □

Presented at the AACT Annual Technical Seminar