Maple candy research part I
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The goals of this project are to improve the overall quality of maple sugar, molded maple sugar, maple sugar pieces or maple sugar candy which ever name you may be using. Quality is identified in terms of the smoothness, graininess, hardness, shelf life and lack of white spots deep in the pieces or on the surface of the pieces. The second goal is to improve the labor efficiency of making and handling the pieces. The majority of research was conducted on the water jacketed gear pump machine put together by Sunrise Metal Shop. With this unit the temperature of the funnel and piping can be controlled with a thermostatically controlled heating element in the water jacket. The experiments were a cooperation between Merle Maple in Varysburg NY and the Cornell Maple Program. Maple candy can have big differences in texture, hardness, flavor, shelf life and appearance. The initial questions to be answered were “What does a customer want in maple candy?”

- Very smooth – silty – grainy
- Hard – medium – soft
- Mild flavor – strong flavor
- Long shelf life – shelf life not important
- No white spots – white spots not important

In this project the targets were very smooth texture, medium hardness for excellent bulk handling, mild flavor, long shelf life, no white spots and production efficiency.

The factors that are known to influence these outcomes are the finish cooking temperature, invert sugar level, stirring temperature, speed and power of stirring, use of premade fondant, temperature at mold filling, post molding conditions and treatment.

Cooling Temp Differences with Molded Maple Sugar

- >200°F at agitation = a harder candy more suitable for crystal coating
- 190°F to 175°F at agitation = a medium hard candy
- <170°F at agitation = a softer candy but may be too soft to coat or handle
- <150°F when entering the mold = no white spots

To obtain a candy that is both of medium hardness but have no white spots is a conflict of the temperatures necessary. This required many temperature adjustments through the experiments to find a balance.

Stirring

- The slower the stir the more likely the sugar will be grainy
- The faster the stir the less grainy or smoother the candy will be
• Shock stirring makes for smaller crystals that make the candy smoother.
• Seeding with a fine cream or candy can make candy smoother
• Pre-made fondant with reheat and re-stir can make for smoother candy

**Experiments using a soft fondant mixed with freshly cooked maple syrup.** In this first group of experiments the water jacket of the candy machine has been consistently held at 148°F as earlier experiments have shown that going above this level causes the candy to develop unacceptable levels of white spots. A soft fondant much like a very thick maple cream was first created in the gear pump cream machine by cooking the cream to 236°F and allowing it to sit in the cooler for one to two weeks. Then it was added at between 38°F and 42°F to an equal weight of syrup cooked to 252°F. The hot syrup and cold fondant were placed in the candy machine funnel and stirred in the funnel with a mobile commercial mixer to instantly bring the mix in the funnel to between 145°F and 150°F. Molds were then filled from the candy machine. This method made sugar pieces consistently with no white spots at all but would be too soft for handling 20% to 30% of the time. This problem would be less when syrup was cooked to the higher level but still could be a problem.

**Labor efficiency experiments.** During the experiments above, attempts were made to replace the single spout mold filler with a two spout or two head mold filler to speed up the mold filling process. This was accomplished by drilling two holes in an inch and a quarter plastic plug fitting, threading the holes and screwing in two, quarter inch brass fittings centered over the mold cells. This worked very well to fill two cells in the molds at a time. It did not plug easily and was easy to reopen when one or both nozzles would start a next batch slow or out of balance. Next a one inch T with threaded end caps was drilled and threaded with four brass nozzles and four mold cells could be filled at a time. This also worked very well speeding up mold filling 4x. A stainless steel 1” T was created to dispense the mix into the mold cells but it had significant plugging problems and was sent back for reworking.
A test to see if surface white spots could be removed after they had formed. Experiments were also run placing maple candy with surface white spots in small sealable plastic containers soon after production to see if that had any effect on encouraging the white spots to dissolve away. One container of about 30 pieces was placed in the microwave for about 20 seconds, the second was not. In both cases the white spots were no longer visible after being in the package overnight.

Experiments using a hard fondant. The next round of research focused on using a fondant that was cooked to the same temperature as the syrup for making candy so no calculated difference between the fondant and the cooked syrup were necessary. Syrup was cooked to 246°F and run through the candy machine to finish it to a smooth texture with very small crystals, poured into cookie trays and placed in the cooler for one to two weeks. By mixing the cool fondant with the hot syrup the mix was cooled rapidly down to the 145°F to 150°F level that would usually make white spot free candy. Different percentages of fresh cooked syrup to fondant candy were tested to follow how different the candy hardness, smoothness and white spot levels resulted. With the thicker fondant the mobile commercial mixer was not as effective at stirring the mix so the fondant and the hot cooked syrup were added to the floor standing commercial Hobart mixer and stirred until the temperature reached an acceptable threshold between 140°F and 160°F. Often this cooling was reached by the steaming off that occurs during the heat of crystallization. This procedure of making a fondant, cooking fresh syrup, cooling by stirring in the commercial mixer until cooled to a desired temperature then adding to the candy machine produced a fairly dry mix going into the candy machine. Once in the candy machine the stirring, temperature of the water jacket and heat of crystallization created a series of temperatures to record and estimate the importance of each in the process of making the white spot free and smooth candy pieces. In each case in this set of experiments, there will be the finish temperature of the fondant, finish temperature of the fresh cooked syrup, finish temperature coming out of the commercial mixer and the temperature of the syrup as it exits the recycling port of the gear pump on the candy machine. The exit port temperature is used because measuring the temperature of the mix coming into the molds was much more difficult to get and presumed to be the same as it would be coming out of the mold filler port.

Due to issues created by the mix moved from the commercial mixer to the candy machine funnel being at times much thicker than in previous experiments the motor on the candy machine was upgraded from a 1 horsepower unit to a 1.5 horsepower unit and converted from a 110 volt to 220. This solved all issues with the gear pump stalling due to the thick mix.

With 50% fondant, cooked two weeks before to 246°F and 50% syrup cooked to 246°F, mixed in the commercial mixer to 136°F and at the recycling port of the candy machine testing at 144°F a good firm candy was made with no white spots.

With 4# fondant that had been cooked to 246°F two weeks before and 20# syrup cooked to 240°F candy was mixed in the commercial mixer to 148°F and was coming out of the recycling port of the candy machine at 160°F showed a moderate level of surface white spots.

With 2# fondant that had been cooked to 246°F two weeks before and 20# syrup cooked to 240°F candy was mixed in the commercial mixer to 152°F and was coming out of the recycling port of the candy machine at 161°F showed a significant level of surface white spots.
With 7.5# fondant that had been cooked to 246°F two weeks before and 15# syrup cooked to 244°F candy was mixed in the commercial mixer to 159°F and was coming out of the recycling port of the candy machine at 156°F showed a significant level of surface white spots that were very thin on the surface. This kind of white spots are overcome with the crystal coating process.

With 7.5# fondant that had been cooked to 246°F two weeks before and 15# syrup cooked to 242°F candy was mixed in the commercial mixer to 146°F and was coming out of the recycling port of the candy machine at 155°F showed a small level of surface white spots that were very thin on the surface. This kind of white spots are overcome with the crystal coating process.

With 7.5# fondant that had been cooked to 246°F two weeks before and 15# syrup cooked to 238°F candy was mixed in the commercial mixer to 140°F and was coming out of the recycling port of the candy machine at 148°F showed very little white spots that were very thin on the surface.

With 4# fondant that had been cooked to 246°F two weeks before and 15# syrup cooked to 244°F candy was mixed in the commercial mixer to 150°F and was coming out of the recycling port of the candy machine at 149°F showed very little surface white spots that were very thin on the surface.

About two cups of the fondant that had been cooked to 246°F two weeks before was re-liquefied in a microwave and poured into molds then about 15 pieces placed in a cellophane bag. These were held for three weeks and then compared to the candy cooked above to 238°F, 242°F, and 244°F. None of the candy showed white spots at the time of bagging. After three weeks the microwaved candy still showed no white developing on the surface while all of the other samples showed significant white on the surface.
Two cellophane bags of candy each with about 12 pieces of candy with no white spots were assembled. In one the cellophane bags were punctured and in the second the bag received no punctures. After 5 weeks the not punctured bag of candy was showing about 75% of the candy turning white while the bag of candy that had been punctured was showing no white spots.

Usually in this set of experiments the problem with having significant amounts of soft candy did not occur as it did when using the soft fondant. The main negative with this system was the difficulty of getting the mix in the commercial mixer and mix in the candy machine to result in consistent manageable temperatures that eliminated the surface white spots. The second issue is the labor involved in making and handling all the fondant needed to operate this way. The invert sugar level in the syrup to conduct the experiments above ranged between 2% and 3%.

**Experiments that enhanced cooling by placing the fresh cooked syrup in a water bath.** 30# syrup was cooked to 248°F then cooled in a 42°F water bath and chilled to 188°F then mixed in the commercial mixer with 2# fondant that had been cooked to 246°F two weeks before and the mix brought down to 145°F. This mix was moved to the candy machine and when it was coming out of the recycling port of the candy machine at 145°F molds were filled. The final pieces showed no white spots and showed no tendency to be soft. The chilling in cold water took 16 minutes. This procedure was repeated for 4 batches with the same excellent results.
Experiments eliminating the fondant and cooling the fresh cooked syrup in the cooler. In this set of experiments the only fondant used was a very small amount, less than a pound to seed the very first batch of the day. 30# syrup was cooked to 248°F then cooled in a 42°F water bath and chilled to 185°F then mixed in the commercial mixer and brought down to 146°F. Once mixing in the candy machine it was coming out of the recycling port of the candy machine at 152°F. The final pieces showed a tiny bit of white dusting on the face and showed no tendency to be soft.

30# syrup was cooked to 248°F then cooled in a 42°F water bath and chilled to 180°F then mixed in the commercial mixer and brought down to 147°F. Once mixing in the candy machine it was coming out of the recycling port of the candy machine at 151°F. The final pieces showed some white dusting on the face and showed no tendency to be soft.

30# syrup was cooked to 248°F then cooled in a 42°F water bath and chilled to 175°F then mixed in the commercial mixer and brought down to 150°F. Once mixing in the candy machine it was coming out of the recycling port of the candy machine at 155°F. The final pieces showed white dusting on the face and showed no tendency to be soft.

30# syrup was cooked to 248°F then cooled in a 42°F water bath and chilled to 165°F then mixed in the commercial mixer and brought down to 148°F. Once mixing in the candy machine it was coming out of the recycling port of the candy machine at 145°F. The final pieces showed no white dusting on the face and showed no tendency to be soft and very smooth.

The next 10 batches were all run with these same conditions: 30# syrup was cooked to 248°F then cooled in a 42°F water bath and chilled to 165°F then mixed in the commercial mixer and brought down to 145°F. Once mixing in the candy machine it was coming out of the recycling port of the candy machine at 145°F. The final pieces showed no white dusting on the face and showed no tendency to be soft and the texture was very smooth. Invert sugar level of the syrup used in these tests was 1.5%. Then in an attempt to replace the commercial mixer with a maple turntable cream machine to see if this option might work for maple producers who already have this equipment but not a commercial mixer. The turn table was more difficult to work with at first as the mix tended to pile up when it first crystalized but with more experience and some minor adjustments it could be managed with proper attention. The end results were identical as far as no white spots, no soft candy and very smooth pieces.

A final test was run where the same conditions as above were met except the temperature of the water jacket was warmed and the mix warmed to see how much the cooler finish temperature in the commercial mixer allowed the second stir in the candy machine to be higher before the white dusting on the surface of the pieces appeared. 30# syrup was cooked to 248°F then cooled in a 42°F water bath and chilled to 165°F then mixed in the commercial mixer and brought down to 145°F. The water jacket in the candy machine was turned up to 180°F. Mix was used to fill molds when the mix was coming out of the recycling port of the candy machine at 154°F with no resulting white spots. Mix was used to fill molds when the mix was coming out of the recycling port of the candy machine at 161°F with no resulting white spots. Mix was used to fill molds when the mix was coming out of the recycling port of the candy machine at 165°F with just a very small amount of the dust like white spots. Mix was used to fill molds when the mix was coming out of the recycling port of the candy machine at 180°F with white dusting on most of the pieces.
This set of tests seems to indicate that the temperature that the mix is first stirred has some influence over the formation of white spots. Also, the cooler stir in the first mix seemed to reduce how much the mix warmed when being stirred the second time while being stirred in the candy machine.

Another area of labor efficiency has come with the invention of the mold popper. This is a grid of stainless steel bars set up to match the spacing of the maple sugar pieces in the mold so when the mold is properly placed on the grid, the mold can be emptied in just seconds by pushing a rolling pin over the back of the mold allowing the pieces to fall through the grid into a waiting tray. This takes about one tenth of the time to remove the pieces by hand.

These experiments have provided significant information on making high quality maple candy efficiently. The one problem that remains a concern is that the hardness of the candy needed for suitable bulk handling is somewhat inconsistent. Further experiments are being conducted to find a way to improve this consistency and will be written up in Maple Candy Experiments part II.