Ultrasonic Application In Dark Chocolate

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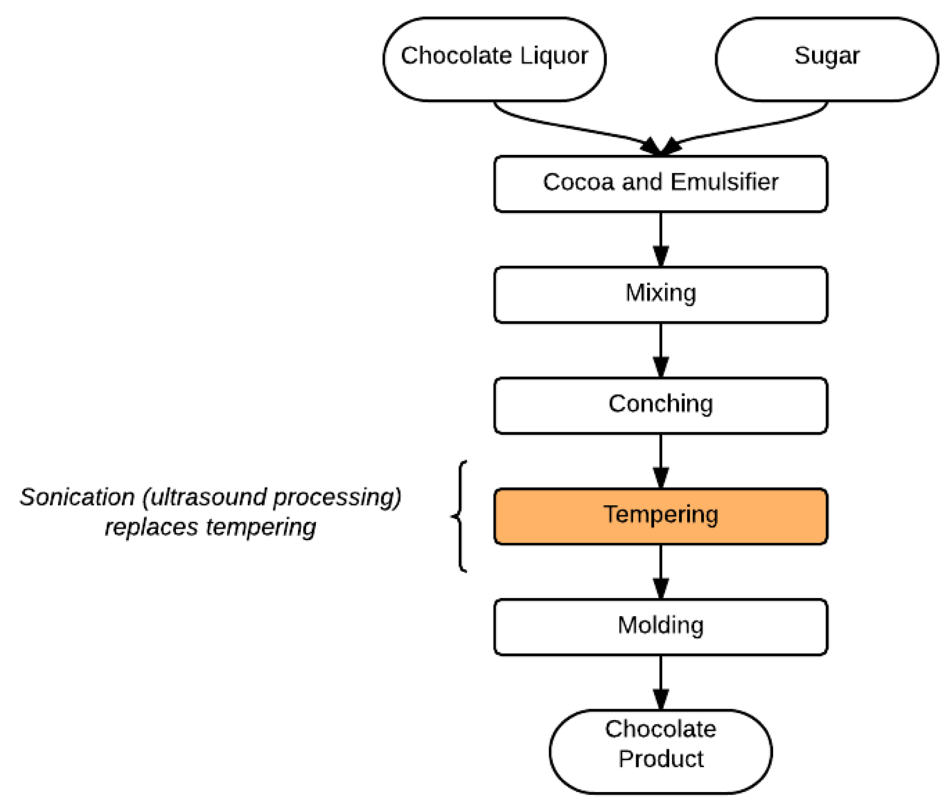
Introduction

Tempering is a process currently used to optimize the final product quality of chocolate; however, previous studies have shown that sonication of chocolate has a comparable quality to that of tempered chocolate. Tempering involves mixing and cooling the liquid chocolate under specific conditions for the chocolate to form in polymorph form V – where maximum consumer satisfaction quality occurs in terms of texture, color, and melting point. The resulting stable crystalline structure prevents formation of fat bloom, therefore providing shelf stability. Fat bloom compromises chocolate quality and appears as a whitish film. Without tempering of chocolate, fat bloom will occur and the cocoa butter will transform into a different polymorphic form with less desirable qualities due to the crystalline structure. Sonication involves application of ultrasonic waves to modify crystalline structure and can be used in place of tempering to provide a similar final product quality. Sonication can provide great benefit to the chocolate industry as it is a less time and energy intensive process as compared to tempering. Figure 1 represents the typical processing strategy for chocolate, indicating where sonication would take place as an alternative to tempering.

Figure 1. Classic Chocolate Processing



Aim

The aim was to expand the research on using sonication to replace tempering by evaluating the effects of varying intensity levels during ultrasonic application on dark chocolate formulation.

As mentioned above, previous research demonstrated that sonication can serve as an alternative processing method to tempering, yielding an equally desirable product. In addition, sonication can save time, energy, and money during processing.

Method

Each chocolate sample contained the same formulation to keep results consistent and allow them to be compared. What differed between the samples, was the processing methods (Table 1). Chocolate formulation: 60% chocolate liquor (Peters Chocolate – ILA, Springfield, IL; containing 50% cocoa butter), 39.95% granulated sugar (Domino Foods, Inc., Yonkers NY), and 0.05% lecithin supplied by Cargill Texturing Solutions (Cargill, Decatur, IL).

Table 1. Chocolate Sample Treatments

Samples	Treatment Time	Abbreviation	Conching	Tempering	Sonication	Molding
Control *	None	C	X			X
Tempered	40 min	T	X	X		X
Sonicated 100%	9 seconds	S100%	X		X	X
Sonicated 80%	9 seconds	S80%	X		X	X
Sonicated 60%	9 seconds	S60%	X		X	X

** Control Sample was cooled to 29 C following conching and molded, no tempering or sonication occurred*

Tempered sample preparation was conducted via the protocol based on McGee (2003) and previous use in this laboratory (Tisoncik, 2010). Chocolate was placed into a stainless steel bowl and stirred to encourage growth of crystals in the structure and facilitate uniform heat transfer. Chocolate melted at 45 C, temperature was maintained for 25 min, followed by cooling to 28 C at a rate of 2 C/min. Once the sample reached 28 C, it was held for 8 min before reheating to 29 C and held for 6 min. This process allows the chocolate to stabilize at polymorph V. Samples were immediately molded.

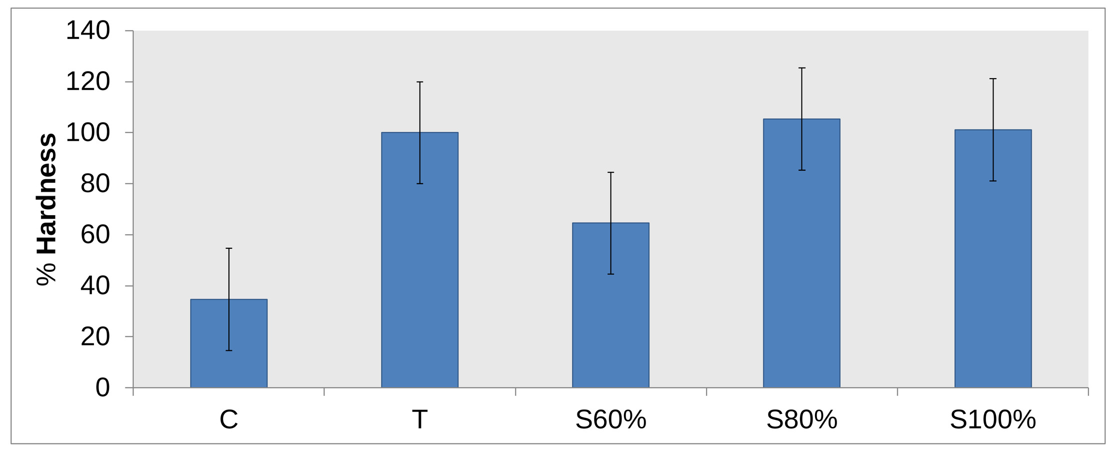
Sonicated samples were subjected to ultrasound treatment using a –MTS system with a 750 W ultrasonic processor (Sonics and Materials, Inc., Newtown, CT). Each sample was processed at 20 kHz with a 25mm (dia.) probe. The probe was inserted into the sample approximately halfway to the bottom and each sample received ultrasonic treatment for 9 s at 33 C. The difference between samples was the intensity (percentage) of amplitude. Samples were molded at 29 C. After the chocolate molds were set, the samples were wrapped in foil and stored at -20 C until evaluation by texture analysis (TA-XT2 Texture Analyzer), melting point analysis (Differential Scanning Calorimetry), and qualitative color analysis.

Results

Table 2. Melting Point Analysis

Sample	Melting Point (C) (Mean +/- SD)	Polymorph Form
Control	33.5 ± 2.5 and 35.6 ± 0.1	IV and VI
Tempered	34.5 ± 0.3	V
Sonicated 100%	34.5 ± 0.1	V
Sonicated 80%	34.4 ± 0.2	V
Sonicated 60%	35.6 ± 0.5	VI

Figure 1. % Hardness of Samples



Legend: C (Control), T (Tempered), S60% (Sonicated 60%), S80 (Sonicated 80%) S100% (Sonicated 100%)

Melting point analysis data (Table 2) indicates that all three sonication treatments impacted the crystalline structure of dark chocolate. The control sample had varying results and was found to have two polymorph forms, IV and VI, which are less desirable. The two higher intensities of sonication exhibited the same polymorph form as tempered chocolate, polymorph V, which is desirable. The 60% sonicated sample was found to be not as effective, as it was in polymorph VI.

Texture analysis (Figure 1) revealed that all three sonication treatments impacted the hardness of dark chocolate. The two higher intensities of sonication exhibited relatively the same hardness as tempered chocolate, which is desirable. The 60% sonicated sample was found to be not as effective, as its relative hardness was about 64.52% of tempered chocolate. The control sample had the lowest relative hardness.

Results Continued

The highest quality samples in terms of color were the tempered, 100% and 80%; followed by 60% and control was the lowest quality. Tempered, 100% and 80% were noticeably more uniform in color and lacked significant fat bloom. The discoloration observed in Control and 60% was due to fat bloom. Fat bloom is an indicator of a lower quality product due to an unstable polymorphic form.

Figure 2. Final Samples

Conclusions

All three levels of sonication intensity yielded more desirable chocolate quality as compared to non-tempered chocolate. However, 100% intensity and 80% intensity performed closest to tempered chocolate while 60% intensity had some quality issues.

These results indicate that 100% or 80% intensity sonication can be used as an effective alternative to tempering chocolate to save time and energy in chocolate production.

References

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