The Flavor of Milk Chocolate

Changes Caused by Processing

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The purpose of this paper is to discuss and demonstrate flavor differences among milk chocolates that are formulated with a constant recipe, altering only the processing parameters. A product development team worked together to develop a protocol. The ground rules were set. The first step was to establish the formula, then determine processing techniques, focus on what processing techniques to alter, analyze the product and finally to evaluate the sensory effects of the process changes.

The goal was to maintain the formula in Figure 1 throughout the test process.

Certain assumptions that would affect flavor were made prior to any samples actually being manufactured. Roasting, the type and amount of raw materials, the refining process and the conching process are all variables that play a part in determining the final flavor outcome.

ROASTING

Roasting parameters could alter the flavor by the selection of bean type, degree of roast (whether it is a low, medium or high roast chocolate liquor) and also the amount of chocolate liquor in the formula.

Formulations using a single bean variety versus a blend of beans may make dramatic flavor differences in a chocolate formula. To date, much of the understanding of chocolate flavor has been based on gas chromatographic and mass spectral data of the volatile aroma fraction of dried and/or roasted cocoa beans and the resulting formulated chocolate. More than 400 compounds have been found in cocoa following fermentation, drying, roasting and conching. Some flavor elements in chocolate are highly volatile compounds contributing sour notes; moderately volatile compounds contributing roasted or flowery notes; and low volatile compounds contributing milky or caramel notes. The ensemble of all these flavor components produces a unique chocolate flavor. Specific beans are chosen for their known contribution to chocolate flavor. For our test, we have chosen to keep the roasting parameters constant using a low roast West African-type chocolate liquor and to focus on the chocolate manufacturing process.

MILK COMPONENT

Milk as a raw material in a milk chocolate

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formulation is critical. Functional performance, sensory properties, cost and storage life are all factors determining the value of milk in a formulation.

The type of milk selected is also a factor. Whole milk powder is the most common milk ingredient in a milk chocolate. Roller-dried whole milk is often used for its high free-fat usage and more yellow color. Spray-dried whole milk is more readily available; however, the process used will determine the amount of free fat available to the chocolate manufacturer. It is typically more white than a roller-dried product. The amount of fat in a whole milk powder may also vary from 26 to 28.5 percent.

A combination of nonfat dry milk and anhydrous milkfat is sometimes used in chocolate formulations for a more buttery flavor and a high free-fat system. This will obviously alter the rheological properties of a particular chocolate formulation and is sometimes used when cost is an issue.

Milk crumb is also another common milk product used to manufacture special formula milk chocolates. The milk crumb helps provide caramel flavors. Maillard browning reactions occur between free amino groups and reducing sugars. These reactions result in brown colors and caramel flavors. The degree of caramelization can be precisely controlled in crumb manufacture.

For this project, roller-dried whole milk powder with a fat content of 28.5 percent was chosen as the milk component.

Formula

Sugar	50%
Milk	19%
Cocoa Butter	16%
Chocolate Liquor	15%
Soya Lecithin	0.3%
Vanillin	0.01%

Figure 1

COCOA BUTTER

Chocolate manufacturers have a number of requirements with respect to the quality of cocoa butter. Prime press cocoa butter from a blend of chocolate liquors might be used to further enhance chocolate flavor or a deodorized cocoa butter could be used to give a more mild chocolate flavor. The choice depends on the intensity of the flavor desired in the end product as well as the melting and solidification properties.

Deodorized cocoa butter was chosen for the test samples so that the flavor of the cocoa butter would not interfere with the chocolate intensity of the samples and to reduce the variability in flavor which can sometimes be found in prime press cocoa butter of similar blends.

FLAVORINGS

Flavorings are added to further enhance or modify already existing notes in a chocolate. The most common flavor additive used in chocolate is vanilla, either in the form of natural vanilla or the now more commonly used artificial vanillin. Salt is the second most common additive. These additions are not used to mask the chocolate flavor, but to intensify it. Vanilla and vanillin help to add creamy notes, whereas salt accents clean, crisp notes and helps to reduce bitterness.

Vanillin, the most common additive to milk chocolate, was the flavoring added to the test samples manufactured.

REFINING

Various types of refining equipment exist in the chocolate industry today. Two-stage refining consisting of a prerefiner and five-roll refining is the most common system and was used for the manufacturing of the test samples. Controls of this equipment set the stage for preconditioning a chocolate mass to achieve an optimal conching process. It is important to envelope the particles with fat so that undesirable absorption of water during refining does not occur. If refining is poorly adjusted, it will be impossible to make up for this during the conching cycle.

The refining process has certain parameters that can be changed that might alter the flavor. Refining will determine the size reduction of a chocolate mass as it is being manufactured. Whether a product is fine, medium or coarse ground will determine the palette's flavor perception. The particles will be coated with fat, which is the flavor carrier. When these particles enter the mouth, the melt, sweetness and mouthfeel all will influence how the product tastes. A product with a high fineness (coarse) will also appear darker in color compared to a low fineness (fine) chocolate. A low fineness product will have more surface area, requiring a greater amount of fat to coat each particle, and will sometimes give a sticky mouthfeel due to the energy required to smooth the particles across the tongue. A coarse product will have more free fat due to less cocoa butter needed to coat the solid particles. This will create a more free-flowing (thinner) viscosity requiring less energy to coat the tongue and giving a different flavor perception.

CONCHING

It is well known that adjustments to conching parameters can modify chocolate flavor. Conching can be manipulated by time, temperature, moisture content and shear. Introducing energy to the product mass in the form of shearing and increased temperature over a period of time will create certain flavor developments. The function of the conche is to remove unwanted flavors but at the same time retain the more desirable ones. The amount of conching is important. Typically, conched chocolate is considered more mellow and blended as compared to unconched chocolate.

Acidity and bitterness are reduced during conching. Ziegleder states that 30–40 percent of highly volatile elements are removed through the conching process and Schneider feels that reduction of acid in a chocolate mass can succeed much easier in a dry substance rather than in a pasty substance. Temperature adjustment will aid in the degree of caramelization based on the Maillard browning reaction, where the basic reaction is between free amino groups and reducing sugars. The Maillard reaction may well depend heavily upon the recipe; the prior treatment of raw materials such as liquor treatment; milk process; crumb manufacturing and the conche temperature. With greater conching intensity, derivatives have been found indicating sugar breakdown. The most prominent in the process is the caramelization of lactose, which would be a source for the malty and intensely caramel notes.

A goal in conching is also to obtain the optimum viscosity (flow properties) at the lowest practical fat content. Key elements in this goal would be moisture reduction, input of energy, control of superfines and amount of free fat available.

There are several different types of conches in the industry today—from dry conching to wet conching to continuous conching. Test samples were manufactured from a wet-conching pilot system.

PARAMETERS

The parameters we chose to focus on to examine the flavor profile of the exact same paste formula follow:

- Conching time
- Conching temperature
- Particle size

These parameters were chosen based on the above previous assumptions. We felt these particular sample types would demonstrate differences by process and by examples.

PROCEDURES

The paste was manufactured using granulated sugar, roller-dried whole milk powder, deodorized cocoa butter, low roast West African-type chocolate liquor, soya lecithin (an emulsifier) and vanillin. The raw materials remained constant throughout the test process.

The products were mixed in a Hobart mixer, measuring each ingredient very precisely, then sent through the refining process and into a high shear Frisse pilot conche. Time, temperature and amperage were monitored throughout the cycle. The product was then standardized to the agreed-upon formula and analyzed. Samples were hand-tempered, cooled and eval-

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The chocolate data shows that physical characteristics are definitely different between conched and unconched chocolate.

uated from a sensory perspective. The initial samples were prescreened by the product development group before sending samples to the full taste panel. The sensory evaluation was conducted by a team of 15 trained panelists using independent descriptive analysis. A 0–7 intensity scale was utilized, with 0 indicating the absence of an attribute and 7 indicating a very strong and overpowering attribute. The process continued for each set of samples until all parameters were adjusted. The samples were evaluated at an average age of one month.

EFFECTS OF CONCHING TIME

Physical Characteristics

Initial paste formulas (the actual refined paste) were exactly the same. The variables were a long conching time process and a short conching time process with a constant conching temperature. The conched sample was conched for 12 hours at 64°C and the unconched sample was conched for 1 hour at 64°C.

When it came time to standardize the products, the unconched sample required additional cocoa butter to bring it to a workable viscosity to make the test samples. The fat content was increased and viscosity altered. The chocolate data in Figure 2 shows that physical characteristics are definitely different between conched and unconched chocolate.

Sensory techniques used for the evaluation of test samples were followed. Each sample used all five senses to capture the full mouth experience and the palette was cleared between each taste session with crackers and water.

Sensory Evaluation

Panelists focused on degree of chocolate, caramel notes, sweetness, dairy and any other perceivable flavor notes. The spider diagram in Figure 3 indicates that the sensory panel found the conched sample to have more chocolate, more caramel and more dairy notes with about the same level of sweetness as the unconched sample. The unconched sample was found to have moderate nutty notes not present in the conched sample. It also had off-notes grouped as raw and unconched at a slight level of detection.

By not conching a milk chocolate, the product has flavor spikes and is unrounded, with hints of raw notes and disjointed flavors. The conched sample is much more rounded, with smooth, chocolatey notes. The milk, sugar and chocolate flavors are well blended together and balanced. According to Ziegleder, completely conched masses will be perceived to give a more fine taste compared to unconched masses due to the penetrating sweetness of the sugar. The roundness occurs by the coalescing of the surfaces and flavor elements becoming more available with the help of the fatty phase. There is still the question of whether chemical reactions occur in conching as they do in roasting. Comparing the two samples, conching does help to round flavor, smooth particles and reduce viscosity (which has an added benefit of reducing cost).

EFFECTS OF CONCHING TEMPERATURE

The second set of samples looked at altering the conching temperature. The low temperature conching was at 64°C for 12 hours and the high temperature conching was at 74°C for 12 hours with constant conching time.

Samples were manufactured using the previously established protocol. The conching times remained the same while altering only the conching temperature. Typically, it is assumed caramelization occurs around 72°C. The data in Figure 4 shows the major difference between the two samples was flowability. But what about the flavor of the samples?

For this set of samples, the panelists were focusing on caramel notes as well as chocolate, dairy and sweetness.

The spider diagram in Figure 5 illustrates

Changing Conching Time

Sample	Time (hrs.)	Fineness (microns)	Viscosity (NCA)	Percent Fat
Long	12	15	155	29.3
Short	1	15	too high	29.3
Short+	1	15	145	34.2

Figure 2

Changing Conching Temperature

Sample	Temp. (°C)	Fineness	Viscosity (NCA)	Percent Fat
Low	64°	15	155	29.3
High	74°	15	100	29.3

Figure 4

Completely conched masses will be perceived to give a more fine taste compared to unconched masses due to the penetrating sweetness of the sugar.

Conching Time Flavor Profiles

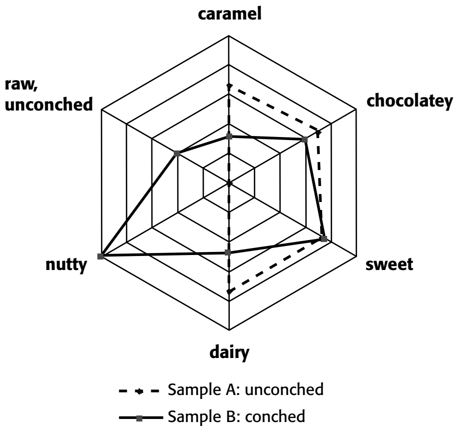

Figure 3

Conching Temperature Flavor Profiles

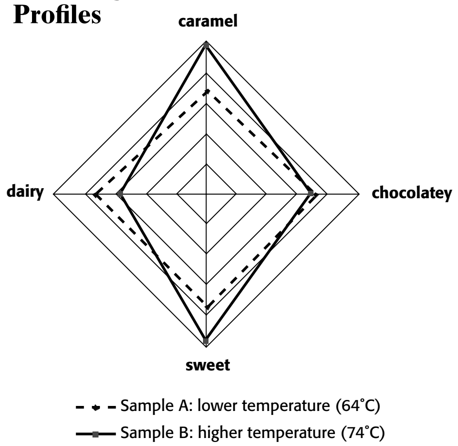

Figure 5

that the higher-temperature sample had a more pronounced caramel note with slightly less perceivable chocolate notes. The higher-temperature sample is perceived sweeter with less dairy apparent. The flavor perception of a low-temperature, long-time conching cycle shows a well-rounded sample, with milky, chocolatey notes, very even. The high-temperature, long-time conching cycle shows slightly less chocolate notes, with caramel notes perceivable.

EFFECTS OF PARTICLE SIZE

The third set of samples demonstrated varying the particle size of a chocolate mass. Will we see a change in flavor or only in flavor perception?

Samples were manufactured with 15 and 35 microns by adjustments to the refining process of the mass. All conching times and temperatures were held the same at 64°C for 12 hours. The chocolate data in Figure 6 reflects the differences in the physical characteristics, showing differences not only with the particle size, but also with the viscosity at the same level of fat. The physical characteristics of the samples are obviously different, but how did the flavor change?

Results for Fine versus Coarse Chocolate

Panelists concentrated on mouthfeel, sweetness, caramel, chocolate and dairy flavor notes.

Even though the only parameter changed with this set of samples was the particle size, you can see from the spider diagram in Figure 7 that perceptions other than the mouthfeel are also affected. The most notable change is the increased perception of sweetness in the more coarse sample. This sweetness seems to mask the intensity of the caramel, dairy and chocolate notes.

The taste and the flow characteristics of a chocolate mass are developed not only during the conching cycle, but also during size reduction and homogenization in the refining process.

Chocolate refined to a very high degree has a more balanced flavor, while the more

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Changing Particle Size

Sample	Fineness (microns)	Viscosity (NCA)	Percent Fat
Fine	15	155	29.3
Coarse	35	60	29.4

Figure 6

Changing Particle Size Flavor Profiles

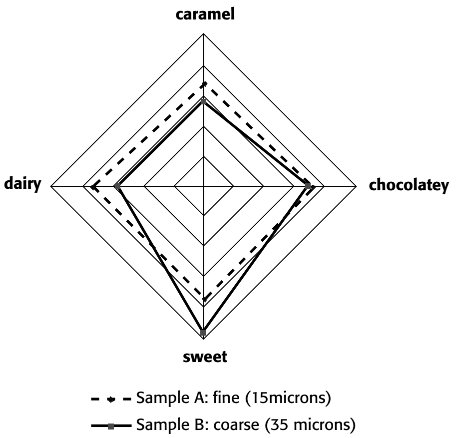

Figure 7

coarse chocolate is perceived as more sweet. The chocolate recipe and the size of the individual ingredient particles largely determine the extent to which product taste can be controlled. Fracturing of particles in the refining process opens the particles up to be simultaneously enveloped by the fat, which will carry the flavor and be further enhanced in the conching process.

CONCLUSIONS

Effects of conching time definitely give a more rounded chocolate flavor. Unconched samples exhibit raw, unconched nutty notes with less overall chocolate flavor. Each specific chocolate recipe will require experimentation to determine the optimum conching time required to meet a specific flavor.

Effects of conching temperature show differences in the degree of caramelization perceived. A low-temperature conching cycle will round all flavors together. A high-temperature conching cycle will promote caramelization. The temperature chosen for a particular recipe will also depend on the treatment and type of raw materials and the final desired flavor.

Effects of Change

Conching Time
Short time (1 hour)
less chocolate; raw, unconched; nutty
Long time (12 hours)
more chocolate, more caramel, high dairy

Conching Temperature
Low Temp (64°C)
chocolate, round; caramel; dairy
High Temp (74°C)
more sweet, more caramel, less dairy

Effects of Particle Size
15 microns
chocolate, round; caramel; dairy
35 microns
more sweet, less caramel, less dairy

Effects of particle size demonstrate not only flavor but texture differences between fine and coarse milk chocolates using the same recipe. A coarse product gives the flavor perception that it is more sweet with less overall flavor. The particle size selected for a milk chocolate depends to a great degree on final product application requirements.

Chocolate flavor and its development is a complex process. True examples indicating the various flavors can be produced from one single formulation using constant raw materials. It is wonderful that chocolate making, with all the scientific reactions that occur in the process, is also an art. The magic and variation of all the flavors available lend themselves to satisfying all of our cravings. □

REFERENCES

Beckett, S.T. *Industrial Chocolate Manufacture and Use.* 3rd Edition.
Kuster, Werner. *Two-Stage Refining—An Important Step for Optimizing the Conching Process.* Buhler AG, Switzerland.
Minifie, B.N. *Chocolate, Cocoa and Confectionery.* 3rd Edition.
Rozin, P. The Flavor-Fusion Illusion. *PMCA Proceedings,* 1996.
Schneider, F. *Is Dry Conching Still Needed?*, 1996.
Seguine, E.S., Factors Influencing the Taste, Selection and Specification of Chocolate. *PMCA Proceedings*, 1998.
Zak, D.L., The Development of Chocolate Flavor. *Manufacturing Confectioner*, November 1988.
Ziegleder, G. *Aroma Development in Conching*. Susswaren 1997.