

Chocolate Flavor Factors: From Cacao to Chocolate

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Abstract. Chocolate is a rich food popular all over the world. At present, there is much research on the rheological influence and chemical composition of chocolate, as well as some research on the flavor compounds of chocolate. Their main purpose is to study the effect of chocolate and the change of the composition to make chocolate healthier. However, few studies focused on the summary and comparison of chocolate flavor optimization. In this paper, the production process of chocolate and the horizontal comparison of each process are comprehensively described, and the research on flavor compounds in chocolate is analyzed. The difference in flavor compounds in different kinds of chocolate and the results of four aspects affecting the flavor of chocolate are obtained. This study makes up for the comparison between different kinds of chocolate production processes and summarizes the composition of chocolate flavor compounds and the influencing factors of chocolate flavor, which provides a reference for future related research. However, there are still some problems that cannot be solved, such as the content change of certain flavor compounds under certain processing conditions, to realize the control of chocolate flavor. Future research can also focus on the influence of human senses on chocolate flavor tasting and the improvement methods.

Keywords: Chocolate; flavor compounds; production processes; influencing factors.

1. Introduction

Chocolate is a very popular food around the world. It can be eaten directly, or it can be used to make cakes, ice cream, drinks, and so on. In some cultures, giving chocolates is a way to express romance and love. The varieties of chocolate can be divided into milk chocolate, white chocolate, dark chocolate, and other chocolate, a total of four kinds. The flavor of different chocolates determines consumers' choice of chocolate products. Therefore, the research on chocolate flavor is helpful to the development of chocolate products in related industries.

Different chocolates are processed in different ways, which can probably be described as melting cocoa butter at 60°C, adding sugar gradually and stirring. Then add milk powder and cocoa powder, stirring and maintaining warmth. Temper chocolate (key for texture and color). Pour into mold, crystallize, harden, and enjoy chocolate [1]. The process of tempering, mainly affects the chemical arrangement of triglycerides in cocoa butter. The cocoa butter is hard and fragile below 27 degrees Celsius, and most cocoa butter begins to melt at 27 to 33 degrees Celsius. When the temperature reaches 35 degrees Celsius, it almost fully melts [2]. And the triglycerides are not arranged regularly at the beginning. If it cools too fast or cools too slowly, or does not cool to the correct temperature during the tempering, the resulting chocolate will melt at a lower temperature. Only under perfect cooling and tempering can an ideal crystal state be formed [3].

The flavor of chocolate consists mainly of 2-methyl propanal, 3-methylbutanal, and ethyl-pyrazine, which come mainly from cocoa beans [4]. Cocoa beans after fermentation, baking, and processing into cocoa powder and cocoa butter will produce a rich aroma, this aroma is the main flavor of chocolate. The origin of different cocoa beans is different, and the aroma produced is not the same. In the production process, the flavor of chocolate will also be lost with high temperature, concentration, refining, and other processes, and even produce inappropriate flavor. Jing Bo and others at Jinan University have demonstrated that paper-wrapped chocolate samples show slight flavor changes [5]. This shows that many factors have different degrees of influence on the flavor of chocolate.

Although many studies are devoted to the optimization of different kinds of chocolate flavors, there is a lack of relevant studies to summarize and compare them. Therefore this article starts with the production process of chocolate, introduces various raw materials, and the corresponding reaction in the production process. Then the composition of chocolate flavor is analyzed, and the influence of objective factors on chocolate flavor is studied.

This article aims to introduce the production process of different chocolate, as well as the corresponding chocolate flavor characteristics and various factors affecting the flavor of chocolate.

2. The Craft of Chocolate-making

2.1. Production process and classification

2.1.1. Procedure.

The chocolate-making process can be roughly described as: The first step is to melt the cocoa butter at a low temperature, usually around 60 degrees. The second step is to add sugar at a small amount of time and stir constantly. Third, add the milk powder or cocoa powder in turn, while stirring quickly and keeping warm. The fourth step which is the most important step in making chocolate, is tempering. It determines the texture and color of the finished chocolate. Then the tempered chocolate is poured into the mold, and after crystallization and hardening, you can get chocolate [1].

In the process of making chocolate, the most important raw material is cocoa powder, which determines the color, aroma, taste, and other factors of chocolate. By processing cocoa beans, cocoa powder can be produced. After cleaning the cocoa beans and filtering out impurities, the cocoa beans are crushed and finely ground to produce a liquid known as chocolate liquor. And the cocoa butter in it can be reduced from 55% to 10% to 24% or less after hydraulic pressure. The residual solids, also known as press disease, can be processed to produce cocoa powder [6].

2.1.2. Classification.

At present, the common categories of chocolate are white chocolate, milk chocolate and dark chocolate, and other chocolate. This article will also focus on analyzing the characteristics of these four types of chocolate.

For white chocolate, white chocolate is mainly composed of cocoa butter, milk, and sugar, which does not contain cocoa powder, so the color is milky. Only milk powder is added during processing and cocoa powder is not required.

For dark chocolate, it has a higher cocoa content, so the taste is very mellow, the cocoa flavor is stronger, and the taste is more bitter. No milk powder is added during processing, only cocoa powder is added. The amount of sugar added can be adjusted according to the needs, and the dark chocolate is divided into sweet, semi-sweet, and bittersweet chocolate. Sweet chocolate requires more sugar, sometimes the same amount as cocoa and butter. Semi-sweet chocolate contains less sugar than sweet chocolate. Bittersweet chocolate has less sugar and more cocoa. The greater the proportion of cocoa powder, the less sweet the chocolate [6].

For milk chocolate, milk powder is added based on dark chocolate to obtain the flavor of milk. It requires a lower content of cocoa powder and a higher content of cocoa butter.

For other chocolate, the processing process is similar to other types of chocolate, just according to the taste of the chocolate, add the corresponding additives before tempering or add a variety of other materials such as nuts, dried fruits, and so on after tempering. Sometimes additional steps are added to increase the flow of chocolate in the mouth. For example, in the process of making air chocolate, more stirring steps will be added to make the chocolate produce pores, and a syringe can also be used to inject air into the chocolate to increase the number of internal pores in the chocolate [7].

2.2. Different Characteristics of Different Types

The white chocolate production process is relatively simple, there is no cocoa liquor refining process, only needs to be properly tempered to achieve a silky taste. The resulting white chocolate is higher in fat and sugar, so the white chocolate is higher in calories. But it's also rich in cocoa butter, which gives it a smoother texture

Dark chocolate is the most basic production process. It does not need to add ingredients such as milk powder but just needs to show the taste of the cocoa powder. In addition to the tempering process that affects the taste of dark chocolate, another process that affects the taste of dark chocolate is the addition of sugar. As mentioned above, dark chocolate can be divided into three types according to different levels of sugar content. Semi-sweet chocolate and bittersweet chocolate are sometimes referred to as couverture (Generally considered to be high-quality chocolate) [6].

Milk chocolate is a combination of white chocolate and dark chocolate. It has added cocoa powder, so its color is generally brown.

Other chocolates are more creative and varied. To meet the taste and functional needs of different people, a variety of different steps are added in the processing process (such as adding additives, concentration, large amounts of mixing, etc.) to achieve the corresponding effect.

For different chocolate, lipid content, sugar content are not the same. White chocolate has the highest lipid content and sugar content because it has a lot of added cocoa butter, so it needs a lot of sugar to mask the slightly bitter taste of cocoa butter. Milk chocolate has a higher lipid and sugar content than dark chocolate. Because it contains dairy products such as milk powder, this increases the content of lipids, especially saturated fatty acids. The sugar in milk chocolate is mainly to increase the sweetness and taste, the sugar content can account for 30% to 70% of the total weight, but the specific value will vary according to the brand and formula. Dark chocolate has the lowest lipid and sugar content and is generally considered a healthier choice. The type of fat is mainly saturated fatty acids, and the sugar is mainly natural sucrose and fructose, almost no added sugar, so it is relatively healthy for the human body.

3. Chocolate Flavor Composition

3.1. Chemical Composition of Flavor Compounds in Chocolate

Different types of chocolate have different types and amounts of flavor compounds. According to Jina Lin's research, white chocolate contains the least variety of aroma compounds, with a total of 25 aroma components detected, milk chocolate detected 102 aroma components, 66% dark chocolate, and 85% dark chocolate detected 107 and 112 aroma components, respectively. 13 of the four kinds of chocolate have a common aroma component, and the common aromatic compound content is different, thus forming the unique aroma of various types of chocolate [8].

The main aroma substances of white chocolate are 3-hydroxy-2-butanone, propylene glycol, butyric acid, etc. The main aroma substances of milk chocolate are isovaleraldehyde, 2-heptanone, 2, 3, 5-trimethyl pyrazine, and so on. The main aroma substances of 66% of dark chocolate are isovaleraldehyde, limonene, isoamyl acetate, and 85% of dark chocolate are isovaleraldehyde, isoamyl acetate, 2, 3, 5-trimethylpyrazine [8].

Different cocoa beans volatilize flavor compounds are not the same, which also directly affect the taste of chocolate. For example, Yue Lang et al. analyzed and studied the types of volatile aroma components of cacao beans with three different genotypes, ZYP11-9, STS16 and ZYP6-11, during the fermentation process, and found that the fermentation time of cacao beans had a great impact on aroma substances, and the types and contents of aroma compounds in cacao beans with different genotypes were different after fermentation [9]. Cocoa beans are the source of cocoa powder, cocoa powder is the main material of chocolate production, so in the future in the study of chocolate flavor

or production, should choose the corresponding cocoa beans, can not randomly choose a cocoa bean to carry out any chocolate flavor analysis.

3.2. Method for Determination of Aroma Compounds in Chocolate

There are many ways to determine the aroma compounds in chocolate. Lin Jina used the thermal desorption - GCMSD method for analysis. After the volatile compounds in the sample were absorbed, they were analyzed by GCMSD through the automatic thermal desorption instrument. After that, the analyzed mass spectra were retrieved by the NIST W8N08L standard spectrum library to determine its composition. The relative contents of each component in volatile compounds were obtained by the peak area normalization method [8]. According to the Nestle Products patent, the technique disclosed in U.S. Patent NO.6090427 can also be used to extract volatile cocoa flavor compounds from ground cocoa [10]. Yvonne Guckenbiehl et al. used stable isotope dilution analysis (SIDA) and gas chromatography-mass spectrometry (GC-MS) to analyze the aroma compounds in chocolate through different model systems [11].

4. The Influence Factors of Chocolate Flavor

4.1. The Origin of Cocoa Beans

Cocoa beans can have different flavors depending on where they come from. For example, the volatile content of Colombian cocoa beans is slightly lower than that of other countries of origin [12], and the relative content of volatile substances in Ecuador's cocoa liquors is the highest [13], and its liquor contains more esters [14].

Because cocoa beans in different regions are greatly affected by temperature changes and soil composition, they have different flavors and cocoa beans are mostly produced by a large number of independent farmers, the resulting cocoa beans have significant heterogeneity and fragmentation. However, the standardization of cocoa beans is of great importance to the chocolate industry, because the chocolate industry needs a large amount of cocoa powder of the same quality to meet the needs of the production line.

4.2. Course of Working

The flavor of chocolate is mostly affected by cocoa powder, which comes from cocoa beans, so the processing of cocoa beans has a great impact on the flavor of chocolate. During the processing of cocoa beans, fermentation, and roasting have the greatest influence on the flavor of cocoa beans. Lukeman Haruna et al. found that proper fermentation time can increase the positive flavor properties of cocoa beans, such as cocoa, fruity, floral, and so on, and reduce the astringent bitter polyphenols in beans [15]. Using tetramethylpyrazine and trimethyl pyrazine as indicators of roasting degree, Valerie Lemarcq et al. tested the comparison of chocolate produced from microwave-baked beans (450W-55 minutes, 600W-35 minutes, 900W-20 minutes) and convection baked beans (130°C-30 minutes). It turns out that microwaving the cocoa beans produced more intensely scented chocolate. This may be because microwave baking is more uniform. At the same time, microwave-baked beans can produce cocoa liquor with slightly higher oxidation, promoting the additional formation of aromatic compounds, which is conducive to the formation of the final aroma profile [16].

4.3. Packing Material

Different packaging also affects the flavor of the chocolate. Jing Bo et al. quantitatively analyzed the change of substance content in the samples utilizing the evaluator's smelling analysis, tasting analysis, and gas chromatography-mass spectrometry (GC-MS). The results showed that the chocolate of paper packaging materials had similar odor characteristics of acetaldehyde (grass flavor) and benzaldehyde (bitter almond flavor) to a certain extent [5].

4.4. Human Sense

The flavor of chocolate will also show different degrees and types of flavor according to different people's sensory performance. This is influenced by many factors, such as age, gender, lifestyle habits, adaptability, etc. Women are generally more sensitive to taste [17], and taste impairment increases with age [18]. In addition, the human body will adapt to the bitter and sweet taste of chocolate, but there are individual differences [19].

Overall, the influence of the human senses on the flavor of chocolate is very subjective, and it depends on the sensitivity of the individual to different tastes.

5. Conclusion

This paper introduces in detail the production process and characteristics of each kind of chocolate and makes a comparison. The composition of the main flavor compounds of different chocolates and their determination methods were introduced. Research has found that the flavor of chocolate is mainly produced during the processing of cocoa beans. Therefore, in the research chocolate production process or flavor, it is very important to control the flavor of cocoa beans, and it is necessary to choose the cocoa beans corresponding to chocolate, and try to control the standardization. The paper also elaborates on four factors affecting the flavor of chocolate, the most important of which are the origin of cocoa beans and the processing process of cocoa beans, which determine the basis of chocolate flavor. The most difficult factor to control is the human senses, because different people's senses are personalized, and everyone's judgment of the taste of chocolate is relatively subjective. This article summarizes and compares the related research on chocolate flavor so that readers can have a further understanding and reference for the research in this field. In terms of the chocolate production process, this paper lacks the summary and analysis of specific processing steps such as tempering. In terms of chocolate flavor analysis, it fails to solve the problems such as the content change of certain flavor compounds under certain processing conditions, to realize the control of chocolate flavor. In future research, in addition to the specific analysis of flavor substances, future research can also study how to reduce or eliminate the difference in the taste of chocolate taste by human senses and produce products that everyone loves.

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