INFLUENCE OF COCOA AND FAT CONTENT ON HARDNESS AND FRACTURABILITY OF DARK CHOCOLATE

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Abstract: The aim of the study was to evaluate the influence of cacao and fat content on hardness and fracturability in dark chocolate from two different producers (Heidi and Lindt). From each producer dark chocolates with 70-85% cocoa content were chosen, as follows: 75 and 85% cocoa content for Heidi brand, and 70 and 85% cocoa content for Lindt assortment. The content of fat was determined by weighing after an extraction in a SER148 Extraction Unit. Hardness and fracturability were measured at room temperature with a Mark 10 texturometer. The results obtained in texture profile analysis showed a strong influence of fat and cocoa content on the textural parameters of dark chocolate: the greater the content, the easily chocolate fractures.

Keywords: dark chocolate, texture, total fat

Introduction

Chocolate is the main final product of cocoa beans, from which cocoa butter and cocoa solids are extracted. Therefore, cocoa is the fundamental ingredient in chocolate manufacturing. Cocoa beans come from a tree called Theobroma cacao, or 'food for gods'. The tree is restricted to the tropics because of its need of warm temperatures, high moisture, and specialist pollinators. Chocolate is thus a food that is rarely consumed in the same locale as its raw ingredients are produced. Each variety of beans has its own flavor profile, although even the same variety can produce different results depending on where and how it is grown [1].

Chocolate is a dense suspension of fine cacao solids and sugar particles dispersed in a continuous lipid phase [2]. Dark chocolate is also known as "bittersweet" chocolate. It contains a high percentage (>60%) of cocoa solids, and little or no added sugar [3]. According to high-end chocolate makers, the less sugar and more cocoa chocolate bar have, the higher its quality [4]. While preference tests show that going higher than 50-60% cocoa solids is undesirable for most consumers [5], chocolatiers produce bars with up to 90% solids and consider those to be the best.

Dark chocolate is a phytochemical-rich food, which is recommended by health professionals to be consumed because of multiple components: flavonoids, proteins, lipids - fat stearic acid [6], minerals - Mg, Mn, Zn, K, Cu and P increase with the cocoa content and an opposite effect was observed for Na and Ca [7]. It also contains polyphenols, which have been shown to be responsible for beneficial health effects. The only information that may be useful to the consumer in choosing a healthier bar, with the exception of nutrients, is the % cocoa solids on the label. A significant and linear relationship between % cocoa solids and antioxidants was found [8]. The main limitation of chocolate consumption is its high sugar content, but many popular snack foods and soft drinks contain more sugar than milk chocolate, and even more than dark chocolate [9]. Europeans are more likely to consider chocolate a real food that can be part of a balanced diet, while Americans consider chocolate a sinful indulgence [10].

American chocolates have lower cacao content than European chocolates, so sugar content tends to be higher in American chocolates [11].

Chocolate texture and aspect are important attributes in consumer choice and acceptability, although flavour and aroma are key factors in product identification [12, 13]. Aroma of chocolate depends on more than 500 substances contained in a fully grown cocoa bean [10].

Texture is a multidimensional property, comprising a number of sensory characteristics that have a profound effect on consumer acceptance of foods, together with basic taste, aroma and appearance [14]. A glossy appearance and a light to dark brown color are representative characteristics for a good-quality chocolate.

Texture can be defined as 'a group of physical characteristics that arise from the structure elements of the food, are related to the deformation, disintegration, and flow of food under a force, and are measured by functions of mass, time and length' [14].

Texture is also a subjectively experienced parameter that refers to the feel of food in the mouth. Two textural sensory properties are important in chocolate perception: smoothness and hardness. In a study published in 2011 [15], it was demonstrated that the phenomenon of sound extends into the domain of flavor and taste perception. Specifically, extra creamy milk chocolate (30% cocoa) was associated with softer sounding. By contrast, 70% and 90% cocoa chocolates were more strongly associated with angular sounds.

Hardness plays an important role in sensory assessment of chocolate. Dark chocolates show greater bite firmness than milk chocolates, so they are considered to be superior in quality [16],[17]. Excessively soft or hard, poor snap or sticky surface are defects in texture. Mouth feel of chocolate is subjective to geographical location of consumers [12].

Texture of chocolate can be influenced by composition, temperature of storage and consumption, and also packaging [18]. Regarding the composition, a major influence has the cocoa percentage, fat and carbohydrate content, and the emulsifier used.

The properties of hardness and fracturability are important for a quality product. The purpose of this study was to analyze the variation in these textural parameters in correlation with their dependence on the composition of dark chocolate, mainly cacao and fat content.

Materials and methods

Chocolate samples

In this study two different brands of premium dark chocolate were used: Heidi (produced by Heidi Chocolat in Bucharest, Romania) and Lindt (produced by Lindt&Sprungli Sas in France). From each brand two products with distinct cocoa content were chosen, as follows: 75 and 85% cocoa content for Heidi, and 70 and 85% cocoa content for Lindt. All products were purchased from a supermarket in Suceava.
Nutritional information for dark chocolate samples provided by the manufacturer is presented in Tabel 1.

Table 1 Nutritional information of dark chocolate samples

Nutritional information for 100g	Heidi 75 cocoa	Heidi 85% cocoa	Lindt 70% cocoa	Lindt 85% cocoa
Protein	9.7	10.7	9.5	12.5
Carbohydrate	32.9	23.9	34.5	21.3
Fat	50.5	56.4	41	46
Dietary fiber	4.4	5.6	12.2	16.3
Ash	2.1	3.2	2	3.6
Potassium	0.223	0.135	0.570	0.126
Sodium	0.042	0.011	0.040	0.010
Iron	0.005	0.005	0.005	0.005
Calcium	0.130	0.100	0.140	0.110

Fat extraction and determination

The method for determination of total fat content from chocolate involves a hydrolysis followed by fat extraction in petroleum ether. For extraction a SER148 Extraction Unit was used. The extraction of the hydrolyzed sample was carried out in 70 ml of solvent for 60 minutes. The resulted extract was then dried at 103°C for 30 minutes. The sample was weighed and the result was expressed as g fat/100 g chocolate.

Hardness and fracturability analysis

Hardness and fracturability of chocolate were determined from the texture profile analysis using a Mark 10 texturometer.

At the heart of a digital force gage is a strain gage-based load cell. Strain gages applied to the load cell stretch and retract as a variable force deforms its structure. Deformation of strain gages changes the electrical resistance in the circuit, thereby correlating force to voltage. This signal is converted into a digital signal, further manipulated by a microprocessor, and converted into units of N or other measurement units displayed on an LCD [19].

The samples were cut after the cross fault shapes, with thickness 4 to 5 mm, penetrating 3 to 4 mm, for about 10 seconds at 18°C, using a Bond knife.

In a study on the optimum storage temperature of the chocolate, the results showed that keeping 18°C is better than 30°C because it significantly reduces the changes in chocolate structure allowing the texture and sensory attributes to remain unchanged [20].

Results and discussion

Total fat content of dark chocolate

Samples of premium dark chocolate from two producers (Heidi and Lindt) with different cocoa content (75 and 85%, and 70% and 85% respectively) were analyzed to determine the fat content, fracturability and hardness.

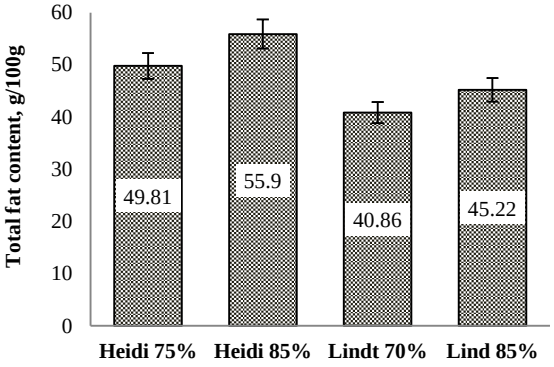

Fig. 1 Total fat content of dark chocolate

Total fat content determined for dark chocolate samples is presented in Fig. 1. For all samples were measured contents very close to the levels provided by the manufacturer and marked on the label. Dark chocolate samples with 70% and 75% cocoa content had lower levels of total fat than dark chocolate with 85% cocoa content. For Lindt assortment with 70% cocoa content Miller *et al*. [21] reported a content of fat of 40.7 g/100 g that is similar to the level determined in this study (40.86 g/100 g). The greatest fat content was obtained for Heidi assortment with 85% cocoa content and was 55.90 g/100 g of chocolate.

Another purpose of the analysis of total fat content of dark chocolate was to highlight the difference in this parameter between dark chocolates with the same reported cocoa content that are produced by distinct manufacturers. Therefore, the assortments with 85% cocoa content were compared. As it can be noted, dark chocolate produced by Heidi had a greater content of fat (55.9 g/100 g). In comparison with the similar assortment manufactured by Lindt, this sample contained 10% more fat.

Hardness and fracturability

Force-displacement curves showed how much force [N] was needed that piece of chocolate to break. The variation of hardness and fracturability of chocolate is presented in Fig. 2 (Heidi) and 3 (Lindt). Table 2 presents the values measured for hardness and fracturability, based on the texture profile analysis of Heidi and Lindt dark chocolate.

Table 2 Hardness and fracturability of Heidi and Lindt chocolate

Heidi 75%	66.26	14.98
Heidi 85%	53.56	8.32
Lindt 70%	99.58	15.1
Lindt 85%	93.28	9.28

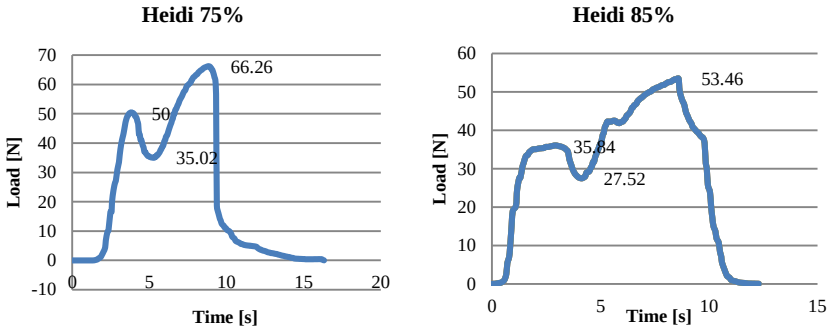

Fig. 3 Texture profile of Heidi assortments with 75% and 85% cocoa content

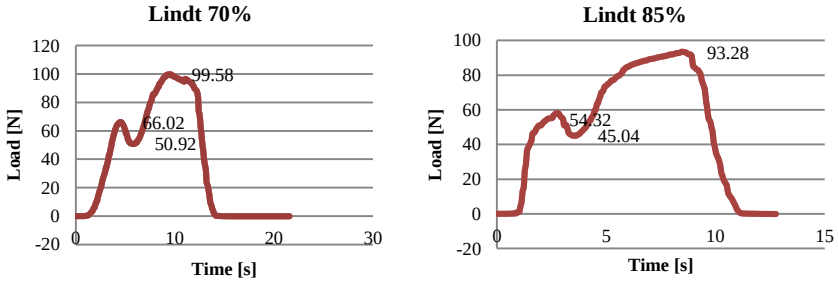

Fig. 4 Texture profile of Lindt assortments with 75% and 85% cocoa content

As both the table and Fig. 2-3 show, dark chocolates with higher cocoa content displayed slightly reduced hardness. On the other side, the fracturability of chocolate samples increased with the increase of cocoa content. By studying the values arising from the texture profile a strong association was found between hardness and fracturability and the cocoa content of dark chocolate. Therefore, the proportion of fat could be manipulated to control softness and hardness of dark chocolate, with implications on quality control and production cost.

Among the studied samples, Lind chocolate with 70% cocoa content had both the highest hardness and reduced fracturability. Previous research has shown that compared to milk and white chocolate, dark chocolate has high values for all rheological parameters because of the highest aggregate structure with the less avoid spaces between particles [22]. In another research, focused on the thermal, structural and rheological characteristics of dark chocolate with different compositions, it was found that the composition of chocolate samples in fat and nonfat cocoa solids, and sugar content, affects the rheological behavior of the product [23].

Conclusion

This paper presents the results of a study on the influence of cocoa and fat content of premium dark chocolate on the textural parameters hardness and fracturability. Four samples of chocolate with different cocoa content, produced by two manufacturers were analyzed, as follows: dark chocolate from Heidi brand with 75 and

85% cocoa content, and two assortments of dark chocolate with 70 and 85% cocoa content from Lindt brand.

The data obtained showed an increase in the fat content of chocolate with the cocoa proportion used in product manufacturing. Moreover, the proportion of cocoa had a strong influence on the textural properties of the dark chocolate. Chocolate hardness decreased with cocoa content, making the product more susceptible to changes in the structure.

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