STABILITY OF CHOCOLATES ENRICHED WITH COCOA SHELL DURING STORAGE

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Introduction

Chocolate is one of the most desirable confectionery products for consumers of all ages. Chocolate industry generates large amount of by-products in pre-processing and processing phases, among which is cocoa shell. It is separated from the bean before or after the roasting. Since this by-product is rich in dietary fibers, proteins, polyphenols and methylxanthines, it represents great material for the enrichment of nutritionally poor products. The stability of chocolate is mainly influenced by cocoa butter re-crystallization during storage, shown through fat bloom (appearance of white layers of cocoa butter on chocolate surface). The aim of this study was to examine the influence of cocoa shell addition on stability of dark and milk chocolate over one year storage period.

Materials and methods

Chocolate production

Chocolates were produced in laboratory ball mill at 55 °C with speed of mixing 60 rpm and mixing time 3 h (chocolates without cocoa shell) and 3.5 h (chocolates with cocoa shell). Cocoa shell was obtained after roasting of cocoa beans (55 min at 135 °C. In dark and milk chocolates with cocoa shell addition (DC15 and MC5, respectively), cocoa shell was added at beginning with cocoa butter. After half an hour cocoa mass and sugar were added. Lecithin (0.4%) was added after 2.5 h and vanillin (0.03%) after 3 h of mixing.

Chocolate mass was tempered (temper index 4-6), molded and cooled (8 °C) for half an hour.

Color

Colour of samples was measured with chromameter Konica Minolta CR-400. The measurement was carried out in the CIEL*a*b* system. Colour was measured after production of samples, after 3, 6, 9 and 12 months. Total colour change (ΔE) (1) and whiteness index (WI) (2) were calculated according to:

$$\Delta E = \sqrt{(L^* - L_0^*)^2 - (b^* - b_0^*)^2 - (a^* - a_0^*)^2} \quad (1)$$

$$WI = 100 - [(100 - L^*)^2 + a^{*2} + b^{*2}] \quad (2)$$

Total poyphenol content

Total phenolic content was determined with addition of aliquot (0.1 mL) of chocolate extract which was mixed with 6 mL of water and 0.5 mL of Folin-Ciocalteu reagent in the volumetric flask. After 6 min, 1.5 mL of 20% Na_2CO_3 was added and the flask was filled up with distilled water to final volume (10 mL). The prepared mixture was left for 2 h at room temperature in a dark place and the absorbance of final solution was measured at 760 nm against the blank. Results were expressed as mg gallic acid equivalents per g of defatted chocolate (mg GAE/g).

Thermo-physical properties

Thermo-physical properties were determined by using differential scanning calorimetry.

Statistical analysis

Least significant difference (LSD) test was used.

Table 1. Chocolate composition

Sample	Sugar (%)	Cocoa mass (%)	Cocoa butter (%)	Milk powder (%)	Cocoa shell (%)	Lecithin (%)	Vanillin (%)
D0	42	36	21.57	-	-	0.4	0.03
DC15	42	21	21.57	-	15	0.4	0.03
M0	45	14.74	24.83	15	-	0.4	0.03
MC5	45	9.74	24.83	15	5	0.4	0.03

Conclusions

Total color change and whiteness index were lower in chocolates with cocoa shell than in control samples. Over time, color change occurred less in chocolates with added cocoa shell. Total polyphenol content in all chocolates did not change significantly through the storage period, although chocolates with cocoa shell had lower TPC because the part of the cocoa liquor was replaced with cocoa shell. Over a period of one year, melting properties were not significantly effected by addition of cocoa shell in dark and milk chocolates.

Acknowledgment

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Results

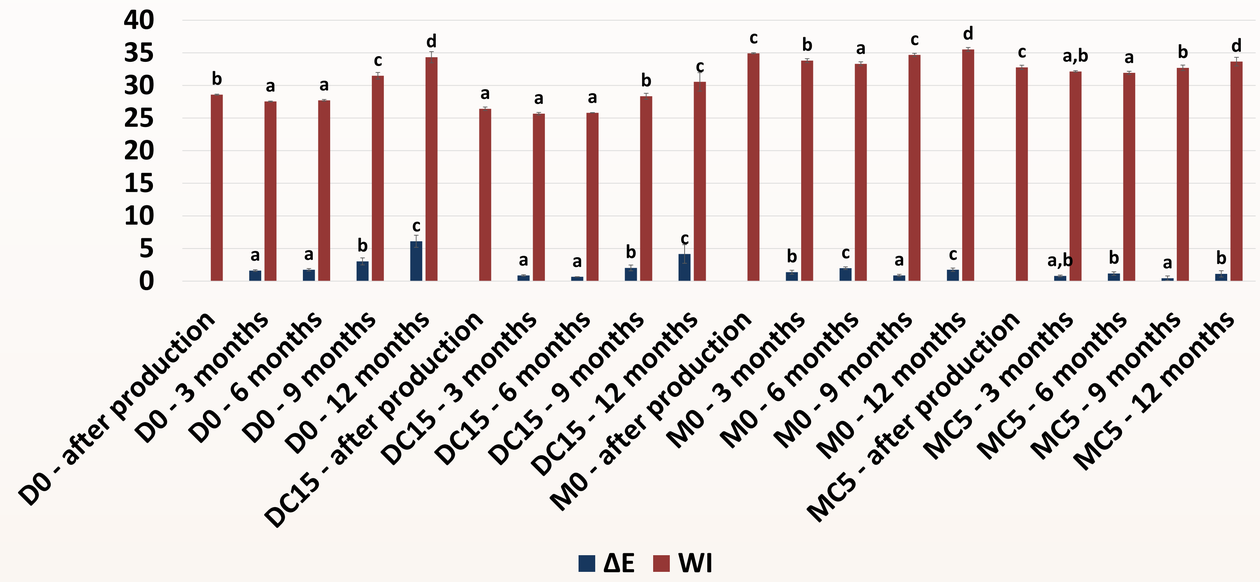

Figure 1. Total color change (ΔE) and whiteness index (WI) of chocolates with and without added cocoa shell

D0 – dark chocolate without added cocoa shell; M0 – milk chocolate without added cocoa shell; DC15 – dark chocolate with 15% of cocoa shell; MC5 – milk chocolate with 5% of cocoa shell; For each parameter and chocolate, means followed by the same letter are not significantly different (P<0.05)

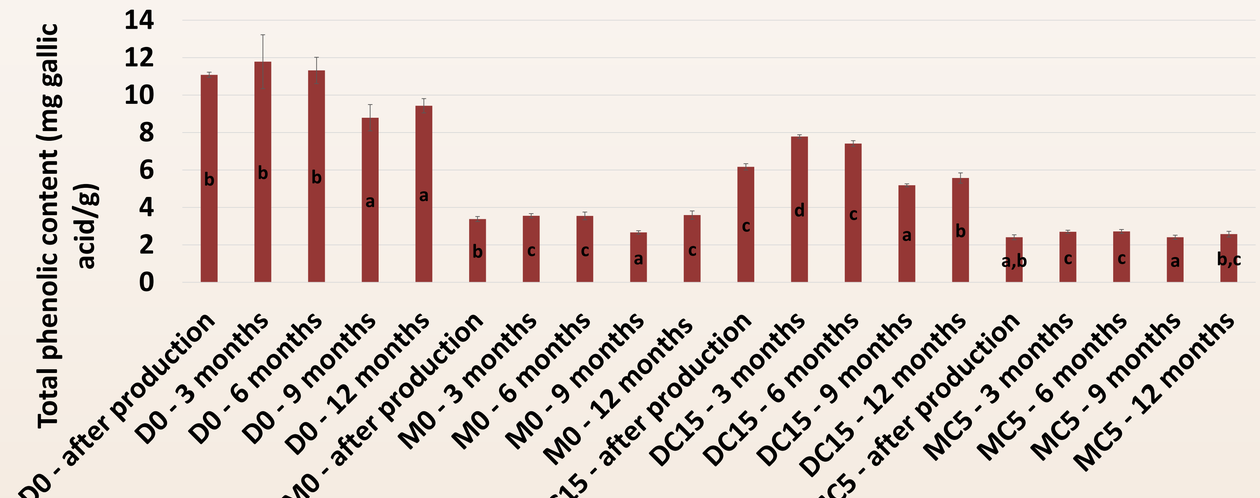

Figure 2. Total phenolic content of chocolates with and without added cocoa shell

D0 – dark chocolate without added cocoa shell; M0 – milk chocolate without added cocoa shell; DC15 – dark chocolate with 15% of cocoa shell; MC5 – milk chocolate with 5% of cocoa shell; For each parameter and chocolate, means followed by the same letter are not significantly different (P<0.05)

Table 2. Melting parameters of chocolates with and without cocoa shell

Sample	T_{onset} (°C)	T_{peak} (°C)	T_{endset} (°C)
D0 – after production	32.32 ± 0.00^{b}	32.45 ± 0.07^{a}	34.7 ± 1.25^{a}
D0 – 3 months	30.98 ± 0.34^{a}	$33.18 \pm 0.08^{a,b}$	34.13 ± 0.10^{a}
D0 – 6 months	31.08 ± 0.18^{a}	34.25 ± 0.69^{b}	35.65 ± 1.04^{a}
D0 – 9 months	32.04 ± 0.37^{b}	34.84 ± 0.02^{b}	36.13 ± 0.09^{a}
D0 – 12 months	$31.24 \pm 0.21^{a,b}$	34.62 ± 0.05^{b}	36.03 ± 0.01^{a}
M0 – after production	25.81 ± 0.31^{a}	31.78 ± 0.12^{a}	32.95 ± 0.27^{a}
M0 – 3 months	$29.27 \pm 0.00^{c,d}$	33.35 ± 0.00^{b}	34.46 ± 0.00^{b}
M0 – 6 months	28.18 ± 0.03^{b}	33.36 ± 0.17^{b}	34.64 ± 0.06^{b}
M0 – 9 months	29.67 ± 0.10^{d}	33.65 ± 0.18^{b}	35.78 ± 0.23^{c}
M0 – 12 months	28.89 ± 0.23^{c}	33.32 ± 0.13^{b}	35.49 ± 0.16^{c}
DC15 – after production	26.41 ± 0.05^{a}	31.98 ± 0.01^{a}	33.18 ± 0.05^{a}
DC15 – 3 months	28.42 ± 0.05^{b}	33.11 ± 0.00^{b}	34.12 ± 0.00^{b}
DC15 – 6 months	27.93 ± 0.50^{b}	33.45 ± 0.43^{b}	34.65 ± 0.09^{c}
DC15 – 9 months	30.22 ± 0.16^{c}	34.61 ± 0.04^{c}	36.35 ± 0.19^{e}
DC15 – 12 months	30.06 ± 0.02^{c}	34.24 ± 0.05^{c}	35.86 ± 0.05^{d}
MC5 – after production	26.21 ± 0.03^{a}	31.37 ± 0.03^{a}	33.34 ± 0.13^{a}
MC5 – 3 months	27.68 ± 0.00^{b}	32.73 ± 0.00^{b}	34.66 ± 0.00^{b}
MC5 – 6 months	27.45 ± 0.05^{b}	32.72 ± 0.00^{b}	34.69 ± 0.05^{b}
MC5 – 9 months	29.79 ± 0.05^{d}	33.39 ± 0.14^{c}	35.35 ± 0.21^{c}
MC5 – 12 months	28.93 ± 0.45^{c}	33.34 ± 0.21^{c}	35.39 ± 0.08^{c}

D0 – dark chocolate without added cocoa shell; M0 – milk chocolate without added cocoa shell; DC15 – dark chocolate with 15% of cocoa shell; MC5 – milk chocolate with 5% of cocoa shell; For each parameter and chocolate, means followed by the same letter are not significantly different (P<0.05)