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Content of bioactive components and sensory acceptability of chocolates enriched with cocoa shell

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Introduction

Chocolates are one of the most favorite confectioneries for all generations. Although, it is often considered unhealthy because of high content of fat and sugar, it is also known that chocolate has high contents of bioactive components such as polyphenols and methylxanthines. Cocoa shell is a by-product of the chocolate industry that also contains these bioactive components which migrated in the shell during the processing of cocoa beans. In this study, we incorporated cocoa shell in the production of dark and milk chocolate as a replacement of the part of cocoa mass. We managed to replace 5% of the cocoa mass in the milk chocolate and 15% of the cocoa mass in the dark chocolate. Along with chocolates with the cocoa shell we produced control samples of dark and milk chocolate.

Materials and methods

Chocoate production

- Chocolates were produced in a laboratory ball mill (D&D metal Osijek, Croatia). 3 kg of stainless steel balls were used for milk chocolates and 2.5 kg for dark chocolates. For production of chocolates with cocoa shell, cocoa shell (obtained after roasting, milled and fraction below 71 µm was used) and cocoa butter were added half an hour before other ingredients. After that cocoa mass, sugar, milk powder (in case of milk chocolate) were added and mixing was continued for 2 h. After totally 2.5 h emulsifiers (lecithin 0.25% and PGPR 0.25%) were added, and after totally 3 h vanillin was added (0.03%). In the case of chocolates without added cocoa shell, the mixing was carried out for half an hour shorter. After production, chocolates were tempered (temperindex 4-6).
- Chocolates were wrapped in aluminium foil and stored in dark place at ambient temperature (22 – 25 °C). Samples for analyses were taken immediately after the production, after 1, 2, 3, 6 and 12 months of storage.

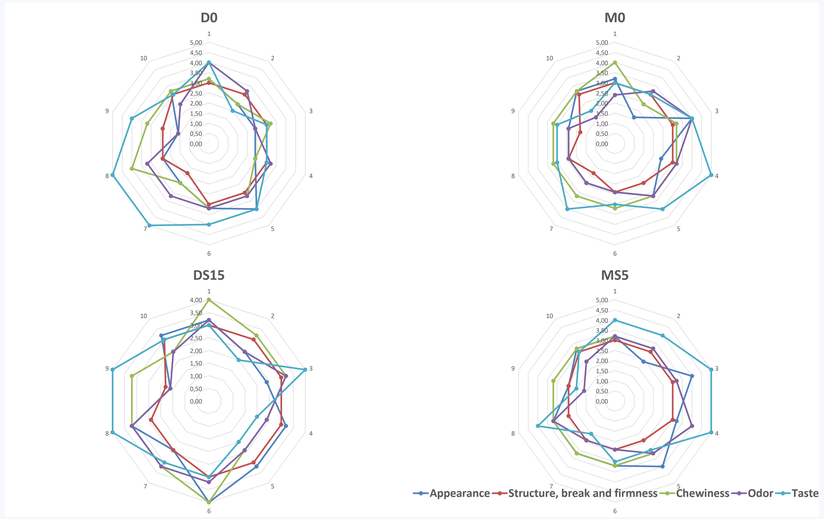
HPLC analysis

- Samples were deffated and after that extracts were prepared (with 70% methanol) in ultrasound bath.
- Methylxanthines and phenolic components that were analysed were: theobromine, caffeine, gallic acid, caffeic acid, *p*-coumaric acid, (+)-catechin, (-)-epicatechin, and (-)-epicatechin gallate.

Sensory acceptability

- Sensory analysis was determined by a group of 10 trained panelists. They scored appearance, structure, break and firmness, chewiness, odor and taste with scores between 1 and 5.

Figure 1. Sensory acceptability of chocolates



*D0-dark chocolate without cocoa shell, M0-milk chocolate without cocoa shell, DS15-dark chocolate with 15% of cocoa shell, MS5-milk chocolate with 5% of cocoa shell

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Results

Table 1. Contents of polyphenols and methylxanthines in chocolates over 12 months of storage

Sample	Month	GA	TEO	CAT	CAF	EPI	CA	EPG	p-CA
		mg/g defatted cocoa mass							
D0	0	0.044 ± 0.000	4.854 ± 0.087	0.721 ± 0.013	0.882 ± 0.021	0.676 ± 0.024	0.035 ± 0.003	0.250 ± 0.024	0.026 ± 0.001
	1	0.044 ± 0.001	4.876 ± 0.062	0.728 ± 0.008	0.895 ± 0.009	0.694 ± 0.003	0.038 ± 0.000	0.311 ± 0.007	0.028 ± 0.000
	2	0.045 ± 0.001	4.971 ± 0.047	0.735 ± 0.008	0.931 ± 0.010	0.684 ± 0.007	0.039 ± 0.001	0.366 ± 0.008	0.028 ± 0.001
	3	0.046 ± 0.001	4.872 ± 0.020	0.744 ± 0.013	0.936 ± 0.016	0.702 ± 0.019	0.040 ± 0.001	0.363 ± 0.002	0.029 ± 0.001
	6	0.045 ± 0.000	4.774 ± 0.004	0.690 ± 0.004	0.798 ± 0.005	0.537 ± 0.003	0.009 ± 0.001	0.262 ± 0.006	0.016 ± 0.000
	9	0.035 ± 0.001	4.819 ± 0.082	0.650 ± 0.043	0.742 ± 0.034	0.548 ± 0.038	0.015 ± 0.002	0.274 ± 0.020	0.015 ± 0.002
	12	0.038 ± 0.002	5.584 ± 0.012	0.677 ± 0.016	0.799 ± 0.023	0.627 ± 0.016	0.025 ± 0.000	0.355 ± 0.012	0.019 ± 0.000
DS15	0	0.029 ± 0.002	4.087 ± 0.019	0.368 ± 0.016	0.644 ± 0.014	0.347 ± 0.016	0.017 ± 0.001	0.294 ± 0.039	0.017 ± 0.001
	1	0.030 ± 0.000	4.111 ± 0.010	0.355 ± 0.008	0.633 ± 0.003	0.334 ± 0.007	0.016 ± 0.000	0.386 ± 0.034	0.017 ± 0.002
	2	0.036 ± 0.001	4.136 ± 0.022	0.386 ± 0.008	0.671 ± 0.017	0.361 ± 0.008	0.019 ± 0.001	0.629 ± 0.021	0.014 ± 0.000
	3	0.038 ± 0.000	4.118 ± 0.007	0.401 ± 0.005	0.688 ± 0.005	0.367 ± 0.003	0.020 ± 0.001	0.457 ± 0.018	0.019 ± 0.001
	6	0.035 ± 0.000	4.055 ± 0.026	0.352 ± 0.002	0.623 ± 0.002	0.277 ± 0.003	0.005 ± 0.001	0.416 ± 0.002	0.013 ± 0.000
	9	0.025 ± 0.000	4.079 ± 0.017	0.346 ± 0.002	0.573 ± 0.006	0.293 ± 0.003	0.006 ± 0.000	0.434 ± 0.006	0.013 ± 0.000
	12	0.026 ± 0.000	4.626 ± 0.018	0.358 ± 0.007	0.626 ± 0.007	0.305 ± 0.005	0.005 ± 0.000	0.566 ± 0.009	0.015 ± 0.002
M0	0	0.012 ± 0.000	3.294 ± 0.033	0.268 ± 0.007	0.332 ± 0.002	0.247 ± 0.003	0.007 ± 0.001	0.138 ± 0.003	0.016 ± 0.001
	1	0.012 ± 0.000	3.297 ± 0.016	0.251 ± 0.003	0.327 ± 0.003	0.237 ± 0.002	0.006 ± 0.000	0.237 ± 0.020	0.015 ± 0.002
	2	0.013 ± 0.001	3.336 ± 0.076	0.255 ± 0.008	0.346 ± 0.011	0.236 ± 0.008	0.006 ± 0.000	0.338 ± 0.002	0.018 ± 0.000
	3	0.014 ± 0.000	3.335 ± 0.010	0.265 ± 0.006	0.343 ± 0.001	0.237 ± 0.003	0.006 ± 0.001	0.200 ± 0.005	0.017 ± 0.001
	6	0.010 ± 0.000	3.300 ± 0.025	0.232 ± 0.006	0.416 ± 0.007	0.208 ± 0.004	0.005 ± 0.000	0.483 ± 0.022	0.014 ± 0.001
	9	0.010 ± 0.001	3.292 ± 0.046	0.263 ± 0.010	0.352 ± 0.008	0.238 ± 0.011	0.009 ± 0.003	0.527 ± 0.081	0.013 ± 0.001
	12	0.008 ± 0.000	3.610 ± 0.057	0.264 ± 0.011	0.385 ± 0.013	0.247 ± 0.013	0.006 ± 0.001	0.640 ± 0.021	0.018 ± 0.002
MS5	0	0.009 ± 0.000	2.973 ± 0.059	0.171 ± 0.006	0.304 ± 0.013	0.167 ± 0.005	0.004 ± 0.000	0.228 ± 0.133	0.014 ± 0.001
	1	0.009 ± 0.001	3.003 ± 0.027	0169 ± 0.006	0.302 ± 0.004	0.167 ± 0.004	0.004 ± 0.000	0.392 ± 0.008	0.013 ± 0.000
	2	0.012 ± 0.001	3.043 ± 0.060	0.175 ± 0.009	0.334 ± 0.018	0.165 ± 0.010	0.005 ± 0.001	0.305 ± 0.058	0.015 ± 0.002
	3	0.012 ± 0.003	3.032 ± 0.044	0.164 ± 0.009	0.364 ± 0.012	0.153 ± 0.008	0.005 ± 0.000	0.446 ± 0.102	0.015 ± 0.001
	6	0.015 ± 0.000	3.037 ± 0.006	0.172 ± 0.001	0.353 ± 0.015	0.155 ± 0.002	0.004 ± 0.000	0.386 ± 0.033	0.013 ± 0.001
	9	0.009 ± 0.000	3.007 ± 0.032	0.182 ± 0.003	0.324 ± 0.005	0.164 ± 0.009	0.005 ± 0.000	0.407 ± 0.012	0.013 ± 0.000
	12	0.006 ± 0.000	3.167 ± 0.027	0.175 ± 0.003	0.330 ± 0.005	0.166 ± 0.005	0.005 ± 0.001	0.511 ± 0.008	0.016 ± 0.002

*D0-dark chocolate without cocoa shell, M0-milk chocolate without cocoa shell, DS15-dark chocolate with 15% of cocoa shell, MS5-milk chocolate with 5% of cocoa shell; GA-gallic acid, TEO-theobromine, CAT-(+)-catechin, CAF- caffeine, EPI-(−)-epicatechin, CA-caffeic acid, EPG-(−)-epicatechin gallate, p-CA-p-coumaric acid

Conclusions

- **Analysis of bioactive components showed that dark and milk chocolate with added cocoa shell had lower content of phenolic components while for methylxanthines this decrease was less pronounced. Dark chocolates had more bioactive components than milk chocolates (Table 1).**
- **Over time, there has been a slight reduction in all bioactive components (Table 1).**
- **Results of the sensory analysis showed that milk chocolates were more acceptable after the addition of cocoa shell, while dark chocolate was slightly less acceptable after the addition of cocoa shell (Figure 1).**