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# MICROBIOLOGICAL STABILITY OF CHOCOLATES WITH ADDED COCOA SHELL

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## Introduction

In the last few years, there is an attempt to use food industry by-products in food production. Because of that cocoa shell is also being investigated for use in the production of confectionery products. The cocoa shell is a valuable by-product because it is rich in dietary fibres and bioactive components such as polyphenols and methylxanthines. During the production process, the cocoa shell is in contact with environmental pollution and it can be contaminated with different microorganisms. In this study, we produced milk and dark chocolate with 5% and 15% of cocoa shell, respectively. These chocolates were stored for one year and water activity and microbiological stability were monitored.

## 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 (DS15 and MS5, 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.

### Water activity

Measurement of water activity was performed with HydroLab 3 which is calibrated in range 0.005 to 0.95 aw.

### Microbiological stability

Microbiological stability of chocolates was determined by measuring total viable count, *Salmonella* spp., *Enterobacteriaceae*, yeasts and moulds for every chocolate.

**Table 1.** Microbiological stability of chocolates during storage period

| | D0 | M0 | DS15 | MS5 |
|---|---|---|---|---|
| | | After production | | |
| *Salmonella* spp. | ND in 25 g | ND in 25 g | ND in 25 g | ND in 25 g |
| *Enterobaceriaceae* (CFU/g) | < 10 | < 10 | < 10 | < 10 |
| Yeasts and moulds (CFU/g) | < 10 | < 10 | < 10 | < 10 |
| Total viable count (CFU/g) | $2.0x10^2$ | $1.5x10^2$ | $1.7x10^5$ | $4.0x10^4$ |
| | | 1. month | | |
| *Salmonella* spp. | ND in 25 g | ND in 25 g | ND in 25 g | ND in 25 g |
| *Enterobaceriaceae* (CFU/g) | < 10 | < 10 | < 10 | < 10 |
| Yeasts and moulds (CFU/g) | < 10 | < 10 | < 10 | < 10 |
| Total viable count (CFU/g) | $3.0x10^2$ | $1.0x10^2$ | $1.8x10^5$ | $6.5x10^4$ |
| | | 2. month | | |
| *Salmonella* spp. | ND in 25 g | ND in 25 g | ND in 25 g | ND in 25 g |
| *Enterobaceriaceae* (CFU/g) | < 10 | < 10 | < 10 | < 10 |
| Yeasts and moulds (CFU/g) | < 10 | < 10 | < 10 | < 10 |
| Total viable count (CFU/g) | $3.8x10^2$ | $1.3x10^2$ | $6.0x10^4$ | $8.1x10^4$ |
| | | 3. month | | |
| *Salmonella* spp. | ND in 25 g | ND in 25 g | ND in 25 g | ND in 25 g |
| *Enterobaceriaceae* (CFU/g) | < 10 | < 10 | < 10 | < 10 |
| Yeasts and moulds (CFU/g) | < 10 | < 10 | < 10 | < 10 |
| Total viable count (CFU/g) | $2.9x10^2$ | $1.0x10^2$ | $1.5x10^5$ | $1.0x10^5$ |
| | | 6. month | | |
| *Salmonella* spp. | ND in 25 g | ND in 25 g | ND in 25 g | ND in 25 g |
| *Enterobaceriaceae* (CFU/g) | < 10 | < 10 | < 10 | < 10 |
| Yeasts and moulds (CFU/g) | < 10 | < 10 | < 10 | < 10 |
| Total viable count (CFU/g) | $5.5x10^2$ | $4.5x10^2$ | $2.8x10^5$ | $2.6x10^5$ |
| | | 9. month | | |
| *Salmonella* spp. | ND in 25 g | ND in 25 g | ND in 25 g | ND in 25 g |
| *Enterobaceriaceae* (CFU/g) | < 10 | < 10 | < 10 | < 10 |
| Yeasts and moulds (CFU/g) | < 10 | < 10 | < 10 | < 10 |
| Total viable count (CFU/g) | $2.6x10^2$ | $1.0x10^2$ | $1.1x10^5$ | $2.2x10^5$ |
| | | 12. month | | |
| *Salmonella* spp. | ND in 25 g | ND in 25 g | ND in 25 g | ND in 25 g |
| *Enterobaceriaceae* (CFU/g) | < 10 | < 10 | < 10 | < 10 |
| Yeasts and moulds (CFU/g) | < 10 | < 10 | < 10 | < 10 |
| Total viable count (CFU/g) | $7.2x10^2$ | $2.7x10^2$ | $8.00x10^4$ | $4.3x10^4$ |

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, ND – not detected.

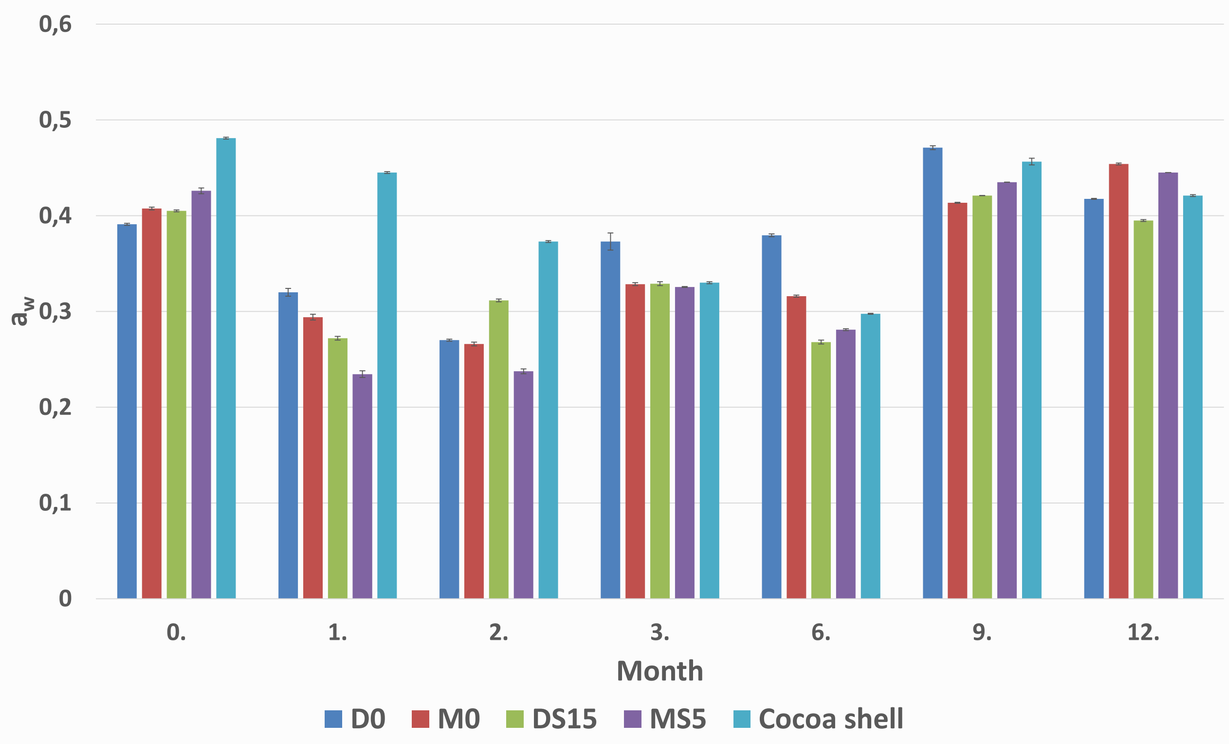


**Figure 1.** Water activity of chocolates during storage period

## Conclusions

- Results showed that water activity (**Figure 1**) was higher in milk chocolates and that with time, water activity increased in milk chocolate with cocoa shell and decreased in dark chocolate with cocoa shell.
- In all chocolates measurements did not show the presence of *Salmonella* spp., *Enterobacteriaceae*, yeasts and moulds (**Table 1**).
- Chocolates with added cocoa shell had a higher total viable count (colony forming units (CFU)) and results showed that they increased within a period of one year (**Table 1**). Dark chocolate with cocoa shell did not comply with regulations for total viable count, while milk chocolates with cocoa shell complied with regulations after production. After first month milk chocolates with cocoa shell also did not comply with regulations. In future research, it is necessary to find an adequate solution for decontamination of cocoa shell.

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