Biblid: 1821-4487 (2013) 17; 1; p 17-19
UDK: 656.073.27

Original Scientific Paper
Originalni naučni rad

PHYSICAL PROPERTY ASSESSMENT OF COFFEE BASED CAPPUCCINO POWDER DURING STORAGE
PROMJENA FIZIKALNIH SVOJSTAVA CAPPUCCINO PRAHA TIJEKOM SKLADIŠTENJA

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ABSTRACT

Instant cappuccino powder is commonly used in households all over the worldnowadays.It is made from varying percentages of instant coffee, sugar, milk powder and different emulsifiers and anti-caking agents and represents a complex mixture of different food powders with different physical and chemical properties. During storage, quality of the powder mixture decreases with increasing levels of moisture or increasing storage temperatures. The objective of this work was to investigate the change in physical properties of cappuccino powder during 4 months of storage. Cappuccino powder was stored at ambient temperature of 20 °C and a relative humidity of 50 – 55%. Changes in particle size, color, moisture, bulk density, cohesion and caking properties were monitored. Significant correlation was found between all parameters of particle size distribution, as well as a significant influence of the moisture content on bulk density values. Color changes based on CIELab L, a, b scale and cohesion property changes were slight and statistically insignificant. However, a significant dependence was found between cake strength and cohesion index - an increase in cohesion index was followed by an increase in cake strength.

Keywords: *cappuccino, physicalproperties, storage, powder*

REZIME

Instant cappuccino prah danas se često koristi u domaćinstvima diljem svijeta. Cappuccino čine promjenjivi omjeri instant kave, šećera, mlijeka u prahu te različitih emulgatora i sredstava protiv zgrudnjavanja te sam cappuccino predstavlja složenu mješavinu različitih tipova prehrambenih prahova sa raznolikim fizikalnim i kemijskim svojstvima. Tijekom skladištenja, kvaliteta mješavine se smanjuje s porastom sadržaja vlage ili porastom temperature. Cilj ovog rada bio je utvrditi promjene fizikalnih svojstava cappuccino praha tijekom 4 mjeseca skladištenja pri temperaturi 20 °C i vlažnosti okolnog zraka 50 – 55%. Praćene su promjene u veličini čestica, boji, sadržaju vlage, nasipnoj gustoći, koheziji i tvorbi čvrstog kolača. Značajna korelacija utvrđena je između svih parametara raspodjele veličine čestica te između sadržaja vlage i nasipne gustoće. Promjene u boji bazirane na CIELab L,a,b skali te promjene kohezijskih svojstava bile su blage i statistički nesignifikantne. Međutim, značajna zavisnost utvrđena je između snage kolača i indeksa kohezije određivanih analizatorom toka prahova – porast vrijednosti indeksa kohezije doveo je do rasta snage kolača.

Ključne riječi:*cappuccino, fizikalna svojstva, prah*

INTRODUCTION

A growing amount of food powders have been developed and commercialized in a powdered form. Such products include coffee and coffee based beverages (e.g. cappuccino) *(Forny et al., 2011)*. Desirable sensory properties, as well as the stimulant effects of caffeine, make coffee one of the most often consumed and most popular beverages in the world *(Niseteo et al., 2012)*.Nowadays, coffee is available in many different forms, ranging from coffee beans, brewed ground coffee, instant granulated or agglomerated coffee and coffee based beverages (different flavor cappuccino, 3 in 1, 2 in 1 mixtures). Instant cappuccino powder is commonly used in households all over the world because of its easy and quick preparation which is especially important in today's fast way of life. As for its composition, cappuccino powder is made from varying percentages of instant coffee, sugar, milk powder and different emulsifiers and anti-caking agents and represents a complex mixture of different food powders with different physical and chemical properties. For example, sugars are known for its dependence on storage temperature and humidity and milk powders for their dependence on surface fat composition *(Kim et al., 2009; Onwulata, 2005)*.During the mixing process it is very important to choose powders with similar granulation so segregation does not occur during storage. During storage, quality of the powder mixture decreases with increasing levels of moisture or increasing storage temperatures, together with possible segregation of the particles.

The aim of this paper was to determine which physical properties and in which way they are affected by storage time. Standard powder analysis methods were applied for particle size analysis (laser diffraction particle sizing), moisture content (oven drying method) and bulk density (jolting volumeter). Changes in color were observed based on CIELab L, a b scale, while the assessment of flow properties was carried out by powder rheometer method (Powder Flow Analyser). The flowing properties were derived from the force that was exerted by the powder on the bottom of the glass cylinder, due to movement of the blade and displacement of the powder *(Wang and Zhou, 2012)*. Parameters defined by Powder Flow Analyser were cohesion index, maximum compression and decompression force, cake strength and mean cake strength.

MATERIALS AND METHODS

Material

Instant cappuccino powder mixture (classic flavor) was manufactured by and obtained from Franck d.o.o., Zagreb (Croatia). Composition of the mixture was as follows (as stated on the label): sugar, glucose syrup, skimmed milk powder, hydrogenated vegetable fat, instant coffee (11%), stabilizer E340, milk proteins, salt, anti-caking agent E551, emulsifier E471, color E160a. Samples were stored at an ambient temperature of 20 °C and 50 – 55% relative humidity for 4 months.

Methods

Particle size

Particle size distribution by laser diffraction method was determined using Mastersizer 2000 coupled with the Scirocco 2000 dry dispersion unit (Malvern Instruments, UK). Measurements were taken at feed pressure of 1 bar and 50 % feed rate, which was increased if observed that the sample flowed poorly through the feed unit. Laser obscuration was kept at 2 – 6% (*Benković et al., 2013, Benković and Bauman, 2011*). Three parallel measurements were performed.

Bulk density

Bulk density was determined by a laboratory made jolting volumeter. Poured bulk density, bulk density after 10, 100 and 1250 taps was determined according to a method described by-*Haugaard-Sorensen et al* (*1978*). All the measurements were performed in triplicate.

Color measurements

Color changes were detected using CIELab L, a, b color scale (L: brightness, a: redness, b: yellowness), as previously described by *Benković and Bauman* (2011).All the measurements were done in triplicate.

Moisture content

Moisture content of the cappuccino powders was determined using an oven drying method. Samples were dried for 3 hours at 105 ± 2 °C in an oven dryer. After drying, samples were cooled in a desiccator and weighed using a 4 digit analytical balance (Sartorius,Germany).Three parallel measurements were performed.

Flow properties

Cappuccino powder flow properties were measured by a powder rheometer – Powder Flow Analyser coupled with TA.HDPlus Texture Ananlyser (Stable Micro Systems, UK). This method is known to be one of the newest in powder analysis (*Abu-hardan and Hill, 2010*) and it is based on measuring the force excreted on the base of the instrument caused by blade movement though the powder cylinder. Cohesion properties were assessed by quick test which determines the cohesion index of the powder, compression and decompression force. Caking properties were determined by caking tests and the results were presented as caking profiles of the samples as well as cake strength and mean cake strength. All the measurements were repeated three times.

Data analysis

Data analysis was performed using Statistica v 10.0 (StatSoft, USA).Correlattion matrices were used as a basic statistic method, with p-levels of 0.05.

RESULTS AND DISCUSSION

The objective of this work was to investigate the change in physical properties of cappuccino powder during 4 months of storage at ambient temperature of 20 °C and a relative humidity of 50 – 55%. Changes in particle size, color, moisture, bulk density, cohesion and caking properties were monitored and the results are presented below.

Table 1. Laser diffraction particle sizing parameters for cappuccino powder during 4 months of storage

Storage time [month]	d (0,1)	d (0,5)	d (0,9)	D [4,3]	D [3,2]	Uniformity
1	39.96±1.16	258.49±7.63	674.61±11.14	314.50±10.66	70.63±2.22	0.69±0.001
2	53.13±5.13	251.04±11.08	639.56±9.50	303.92±13.75	73.81±3.90	0.67±0.001
3	46.55±1.55	254.77±4.66	657.08±46.11	309.21±6.17	72.21±1.25	0.68±0.004
4	63.41±3.18	254.18±5.13	627.55±23.51	303.75±8.21	76.04±1.19	0.65±0.001

Particle size distribution results shown in Table 1 indicate no significant change in particle size parameters during storage. Small differences amongequivalent parameters (e.g d (0,1)) were visible, but they occurred as a result of sampling. Namely, since cappuccino comprised of different types of powders with different physical properties and particle sizes (e.g. sugars, milk powder, instant coffee), it was practically impossible to retrieve a uniform and an approximately similar sample each time during sampling. Furthermore, statistical analysis showed a significant correlation between all particle size distribution parameters and powder uniformity, which meant that the particle size results are highly dependent on the flow of the powder through the measurement cell. Since the flow parameters (air pressure and laser obscuration) were kept constant during the measurement, it can be assumed that the difference in uniformity occurred as a result of sampling.

Bulk density values during 4 months of storage are shown in Fig. 1.

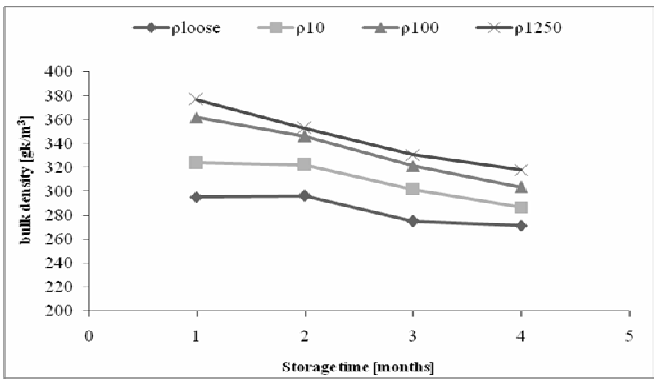

Fig. 1. Bulk density values of cappuccino powder during storage

Bulk density values increased with an increasing number of taps performed on the powder cylinder ($\rho_{loose} < \rho_{10} < \rho_{100} < \rho_{1250}$). A decrease in volume and a consequential increase in bulk density occur as a result of air leaving interparticle space when being tapped.Moreover, all bulk density values drop with an increase in storage time (Fig. 1), which could also be connected to the difference in moisture content of the cappuccino powder.

Table 2. Color changes of cappuccino powder during 4 months of storage

Storage time [month]	L	a	b
1	79.47±0.10	2.21±0.02	7.95±0.01
2	75.01±0.19	1.92±0.03	7.27±0.02
3	82.10±0.02	1.54±0.01	7.68±0.01
4	80.58±0.01	1.83±0.01	7.86±0.01

Color changes shown in Table 2 were slight and statistically insignificant. A slight increase of L values (brightness) and a drop in a (redness) and b (yellowness) values was detected as a result of fading brown color of the instant coffee particles in the mixture during 4 months of storage.

Moisture content, cohesion and caking properties are shown in Table 3. Moisture content showed a consecutive increase with storage time. Cohesion index values did not show a regular drop or rise pattern. Maximum compression force measured when the blade travelled downwards through the powder column showed higher values than the maximum decompression force

measured when the blade travelled upwards through the powder column.

Table 3. Moisture content, cohesion and caking properties of cappuccino powder during storage

Storage time [month]	Moisture content [%]	Cohesion index	Maximum compression force [g mm]	Maximum decompression force [g mm]	Cake strength	Mean cake strength
1	1.44±0.01	19.99±0.33	5172.07±27.44	-825.42±7.42	125.33±1.04	56.03±1.00
2	1.85±0.01	20.38±0.52	5963.07±51.60	-882.58±8.69	127.06±2.00	60.58±0.99
3	2.08±0.01	20.33±0.45	8425.25±73.14	-963.54±2.66	125.72±1.92	61.46±0.97
4	2.26±0.01	15.73±0.36	5985.40±33.56	-929.83±6.14	121.93±1.77	55.43±1.02

These results were in accordance with previous studies by *Ghosal et al. (2010).*Cake strength and mean cake strength values showed no significant change during storage. However, a strong positive correlation was detected between cohesion index and cake strength values – cake strength values increased with an increase in cohesion index ($r = 0.96$, $p = 0.04$). Statistical analysis showed a significant influence ($p < 0.05$) of moisture content on bulk density values.

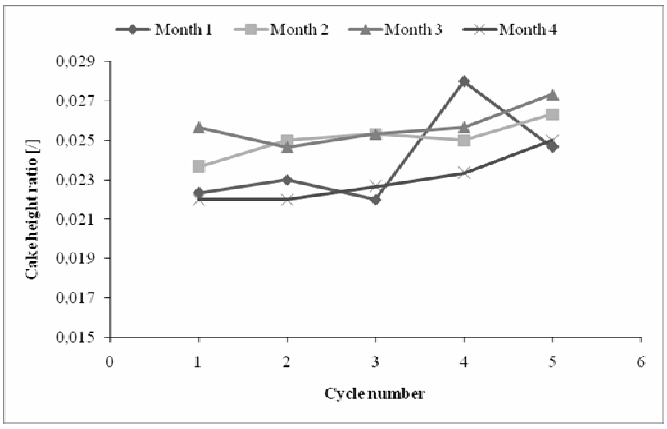

Fig. 2. Caking profiles of cappuccino powder during storage

Caking profiles during 4 months of storage shown in Fig. 2 revealed a slight rise in cake height ratios with increasing cycle numbers, which exhibited a slight dependence of cappuccino powder towards caking.

CONCLUSION

The objective of this paper was to determine which physical properties of instant cappuccino powder change during storage. Particle size distribution parameters showed no significant change, but slight differences between values were detected as a result of sampling.Bulk density values increase with a number of taps employed on the powder cylinder. Furthermore, all bulk density values decrease with increasing storage time. A slight, but statistically insignificant drop was detected in brightness values (L) as a result of brown color of the agglomerates fading during storage. Moisture content significantly affected bulk density values and a positive correlation was determined between cohesion index and cake strength - rise in the cohesion index also caused a rise in cake strength.

ACKNOWLEDGEMENT: The Authors would like to thank Franck d.o.o., Zagreb for supplying the cappuccino powder samples analyzed in this study.

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Received: 28.02.2013. Accepted: 03.04.2013.