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EVALUATING THE IMPACT OF MOISTURE ON MULTIVITAMIN INSTANT GRANULES USING NIR SPECTROSCOPY AND CHEMOMETRICS

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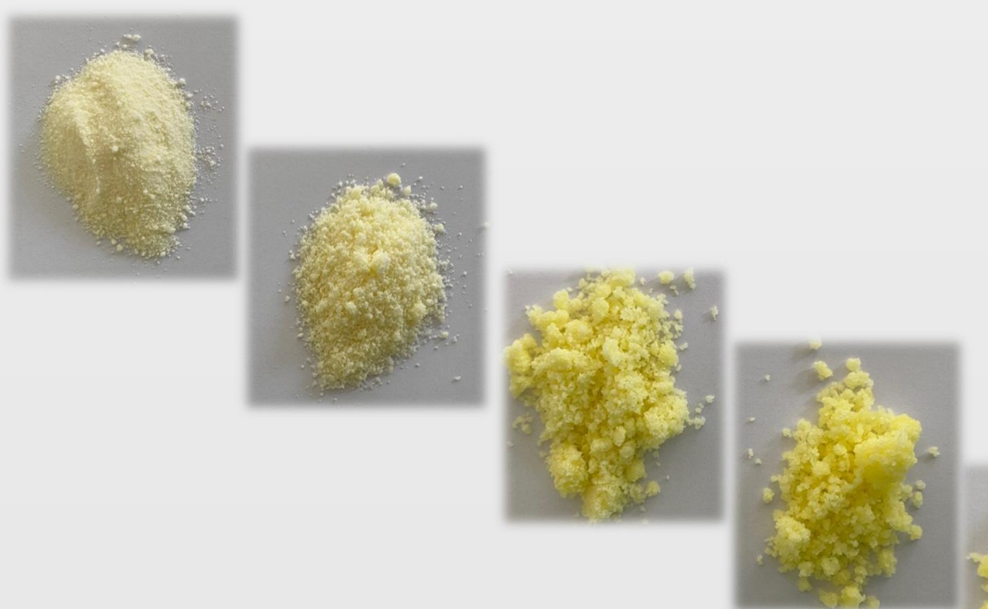
INTRODUCTION

Instant food powders obtained by agglomeration are increasingly popular on the market, primarily due to their excellent reconstitution properties. Among them, multivitamin powders are an important source of different types of vitamins for human body, as they are practical and have alluring appearance and taste. This study investigated how moisture content affects the physical properties and near-infrared (NIR) spectra of multivitamin instant powders.

MATERIALS AND METHODS



Conditioning of the powders to different moisture levels: (1, 2, 3, 4, 6, 8, and 10 %)

Analysis of physical properties and NIR spectroscopy:

- Moisture content (105 °C/ 3h, Inkolab convection oven, Zagreb, Croatia)
- Water activity (Rotronic Hygropalm, Switzerland)
- Color (CIELab color scale)
- Particle size (optical microscopy and image analysis)
- Bulk density and Hausner ratio (jolting volumeter)
- Reconstitution properties (dispersibility and wettability)
- NIR spectroscopy ((Control Development inc., NIR-128-1.7-USB/6.25/50µm, South Bend, USA)
- Chemometrics (Principal Component Analysis (PCA) and Partial Least Squares models (PLS)) (Unscrambler X, Camo Software, Norway)

RESULTS AND DISCUSSION

SAMPLE	Moisture (%)	a_w	*L**	*a**	*b**	Chroma	hue	*ΔE*	HR	d (0.5) (µm)	Dispersib-lity (s)
0	0.80± 0.00	0.435± 0.005	94.50± 0.75	0.47± 0.12	16.60± 0.66	16.62± 0.67	88.40± 0.36	0.00± 0.00	1.18± 0.05	469.40± 15.22	18.5± 2.121
1	1.65± 0.04	0.606± 0.000	90.58± 4.93	0.47± 0.91	19.67± 1.61	19.68± 1.64	88.75± 2.46	5.84± 4.82	1.26± 0.10	419.73± 20.11	44± 9.899
2	3.55± 0.07	0.643± 0.002	92.35± 0.29	-0.86± 0.07	25.95± 0.46	25.96± 0.46	91.90± 0.46	10.34± 0.53	1.35± 0.05	1064.16± 20.23	85± 4.243
3	4.01± 0.01	0.664± 0.007	91.05± 0.46	-1.30± 0.06	29.61± 0.85	29.64± 0.84	92.51± 0.84	14.15± 0.92	1.40± 0.07	1092.94± 14.33	107± 5.657
4	4.56± 0.11	0.710± 0.001	89.9± 0.92	-1.73± 0.19	32.42± 0.77	32.46± 0.77	93.06± 0.77	17.20± 1.00	1.40± 0.01	1280.86± 44.15	122± 1.414
6	6.05± 0.06	0.762± 0.000	84.89± 2.35	-1.35± 0.43	37.75± 1.20	37.78± 1.21	91.97± 1.21	24.01± 0.35	1.36± 0.12	1661.23± 23.11	144.5± 20.506
8	7.30± 0.15	0.789± 0.001	82.68± 0.90	-1.36± 0.21	42.79± 0.72	42.81± 0.72	91.82± 0.72	29.42± 0.36	1.37± 0.10	2304.02± 32.22	141± 14.142
10	7.92± 0.01	0.791± 0.004	80.20± 1.32	-0.99± 0.46	44.09± 1.02	44.10± 1.03	91.30± 1.02	31.67± 0.91	1.18± 0.06	2360.77± 55.67	338± 19.80

Table 1. Physical properties of the analysed powders (mean ± SD)

Moisture content of the powders after conditioning differed slightly than the nominal values, mostly due to the inability to fully homogenize the powders after water addition. The moisture level of sample 10 was much lower than nominal since the sample went through a glass transition which hindered moisture evaporation during drying. Color of the powders changed significantly with moisture content (*ΔE*), with the powder becoming darker (lower *L** values) and shifting towards the green part of the spectrum (lower or negative *a** values) and yellow parts of the spectrum (higher *b** values). Color saturation also rose (Chroma and hue values). Powders with higher moisture content had increased HR values, exhibiting very poor flow and higher mean particle sizes due to lump formation. Dispersibility times also increased with higher moisture content (Table 1).

A consecutive rise in absorbance values is visible with an increase in moisture content (Fig. 1). Also, the absorbance spectra show peaks in the wavelength range 1450 – 1600 nm which is caused by the increase in the amount of moisture in the sample. The developed PLS models (Fig. 2) showed excellent fit between experimental and model derived data for *L** (R^2= 0.827), *b** (R^2= 0.843), Chroma (R^2= 0.843), *ΔE* (R^2= 0.872) and moisture content (R^2= 0.842), while they were less successful in predicting the values of *a** (R^2= 0.236), hue (R^2= 0.122) and aw (R^2= 0.683).

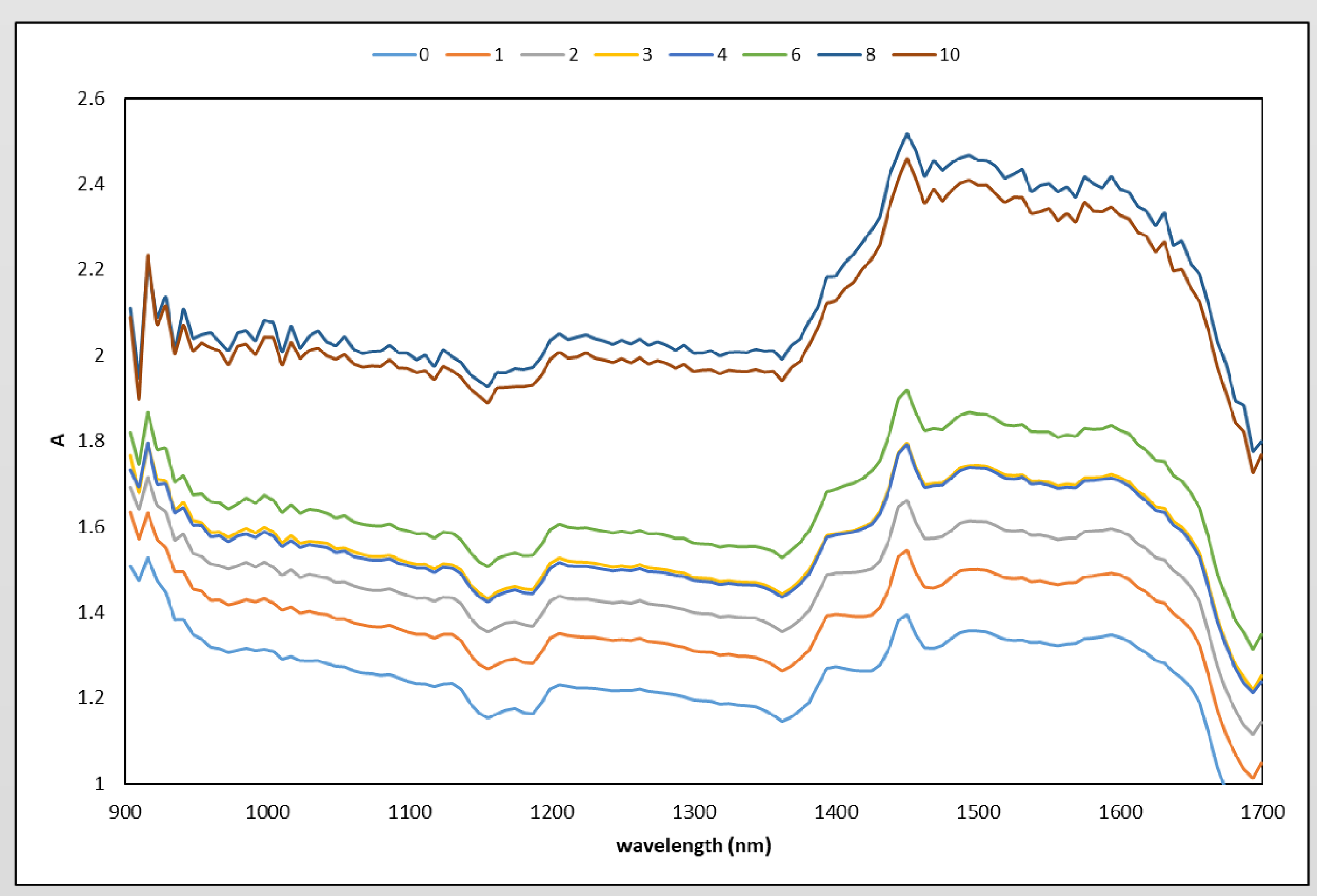


Figure 1. Raw unprocessed NIR spectra of powder samples

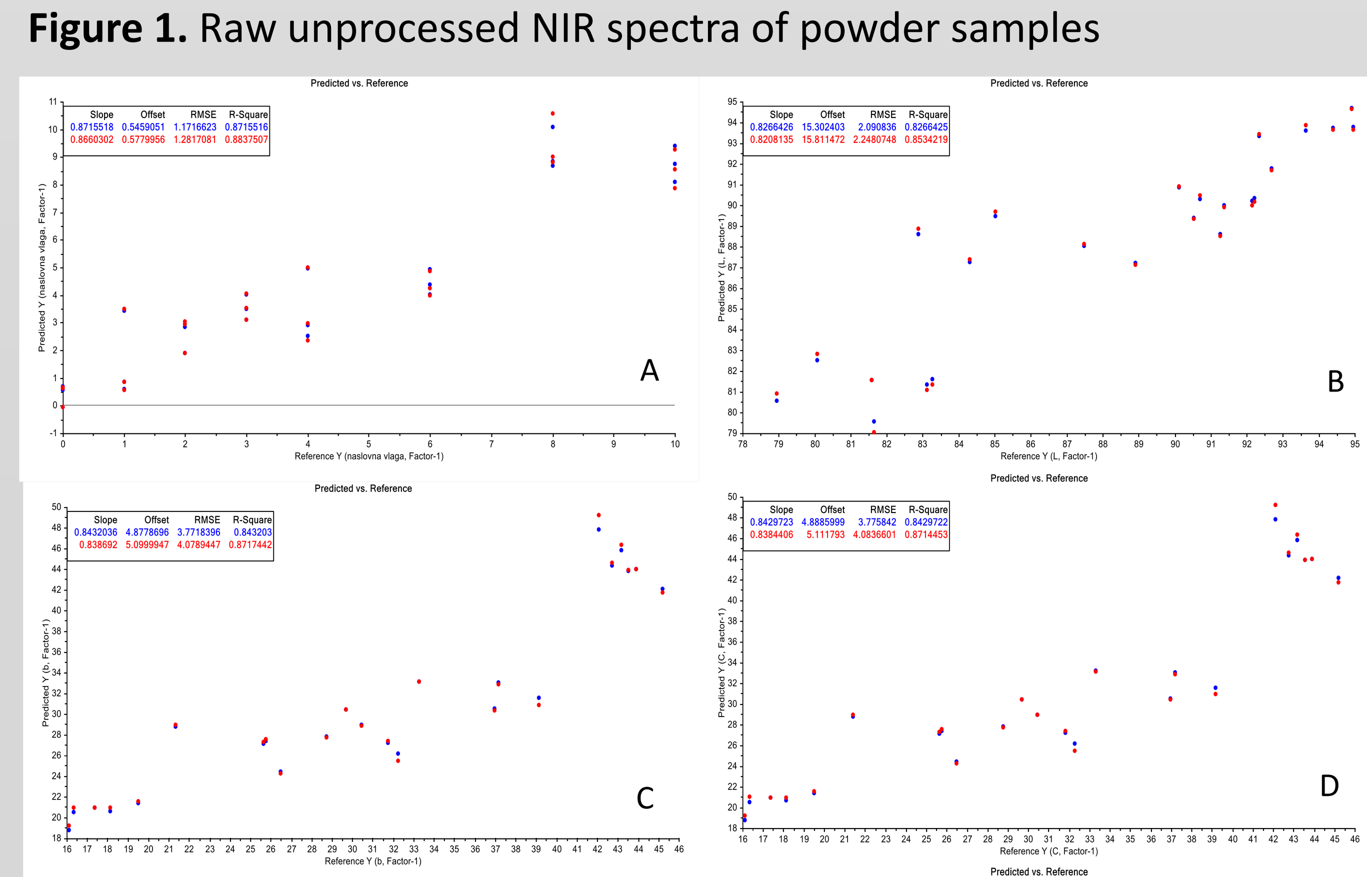


Figure 2. PLS models: A) moisture, B) *L**, C) *b**, D) Chroma, E) ΔE, F) a_w (only models with R^2 > 0.7 are shown)

CONCLUSIONS

These results confirm the applicability of NIR spectroscopy as a fast, on-line method for monitoring moisture content of granulated multivitamin powders.