UNIWERSYTET PRZYRODNICZY w Lublinie
WYDZIAŁ NAUK O ŻYWNOŚCI I BIOTECHNOLOGII

Department of Dairy Technology and Functional Foods
Bartosz Sołowiej, Ph.D., D.Sc., Full Prof.

Rheological, textural properties and surface analysis of food products

Faculty of Food Sciences and Biotechnology
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Faculty Building and Laboratories

Stephan machine:
Emulsion manufacturing, production of processed cheese, cheese sauces, dressings, mayonnaise, etc.

Butler with a capacity of max. 10 l, removable stirrer and the whole device - made of stainless steel.

Thermostat cabinet
Yogurts, kefirs, etc.up to about 50 l

Milk centrifuge, 130 l of milk / h
Rotational speed is 9500 / min max.

- **Cheese kettle** (30 l) + pasteurizer
- **Pneumatic cheese press**

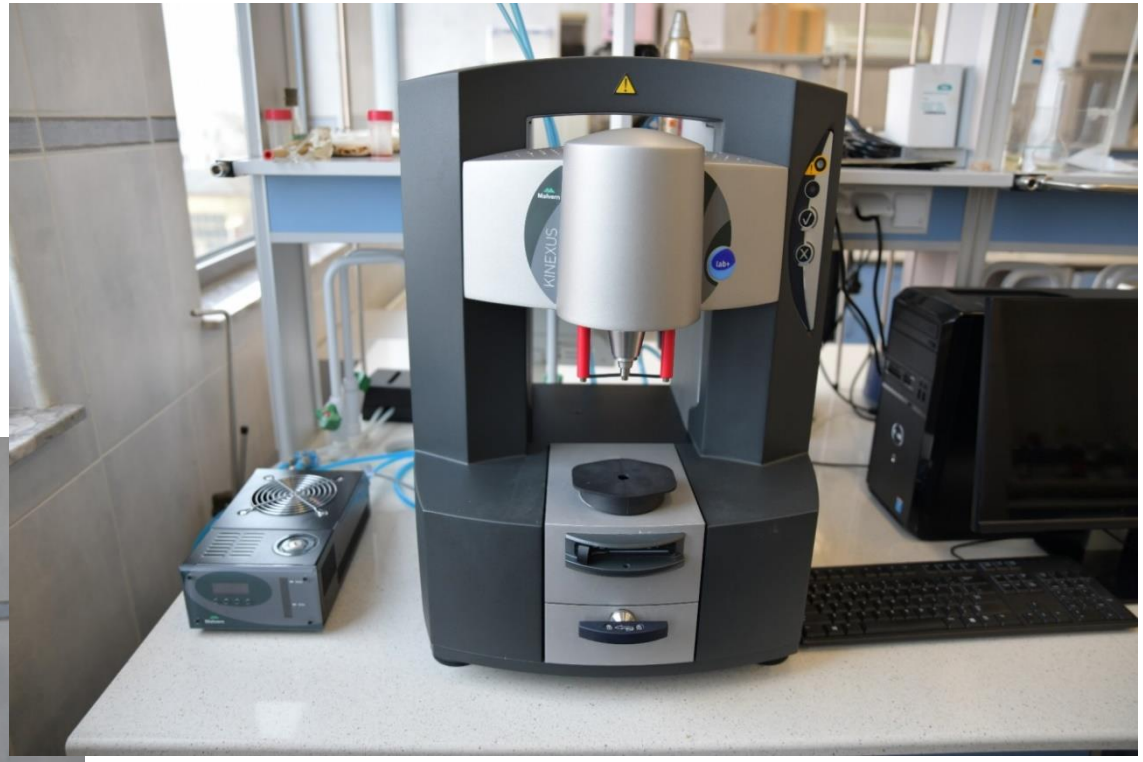
Department of Dairy Technology and Functional Foods – what we test

- Development and **evaluation of texture** (hardness, adhesiveness, cohesiveness, springiness etc.), **rheological** (viscosity, meltability), **surfacial properties: roughness** (palatability, appearance), **optical properties** (microstructure) of various food products. Assessment of above-mentioned properties of commercial food products.
- **Functional properties of proteins and polysaccharides** (viscosity, gelation, foaming).

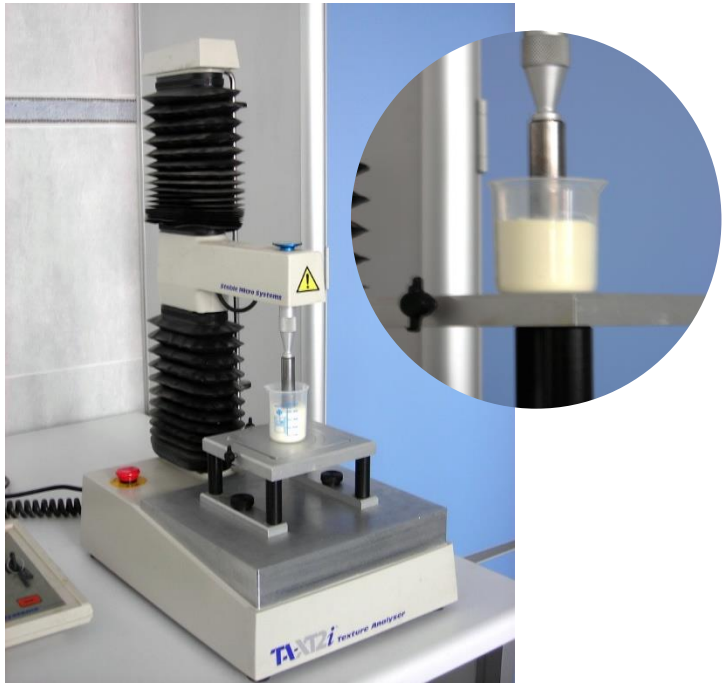
- **Developing food product formulas**, especially **functional foods for athletes, physically active people, and diabetics**: high-protein, low-fat processed cheese and cheese sauces, yoghurts, dairy desserts; protein bars, oat fermented beverages with alternative and unconventional protein sources (edible insects, spirulin, potato protein etc.); non-standard hydrocolloids (kuzu, arrowroot) in vegan jelly production; high-protein sugar-free chocolate, macarons.

Texture Profile Analyser TAXT2i

- Texture Profile Analysis (TPA) (Hardness, Adhesiveness, Springiness, Cohesiveness etc.)
- Relaxation time
- Back extrusion
- Cutting test
- Spreadability
- (np. butter, processed cheese)



Oscillatory rheometer Kinexus Lab+
Measurement of rheological properties - viscoelastic properties (semi-liquid - semi-solid products, e.g. fermented milks, cream, processed cheese, cheese sauces, etc.).



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Effect of whey protein concentrate on physicochemical properties of acid casein processed cheese sauces obtained with coconut oil or anhydrous milk fat

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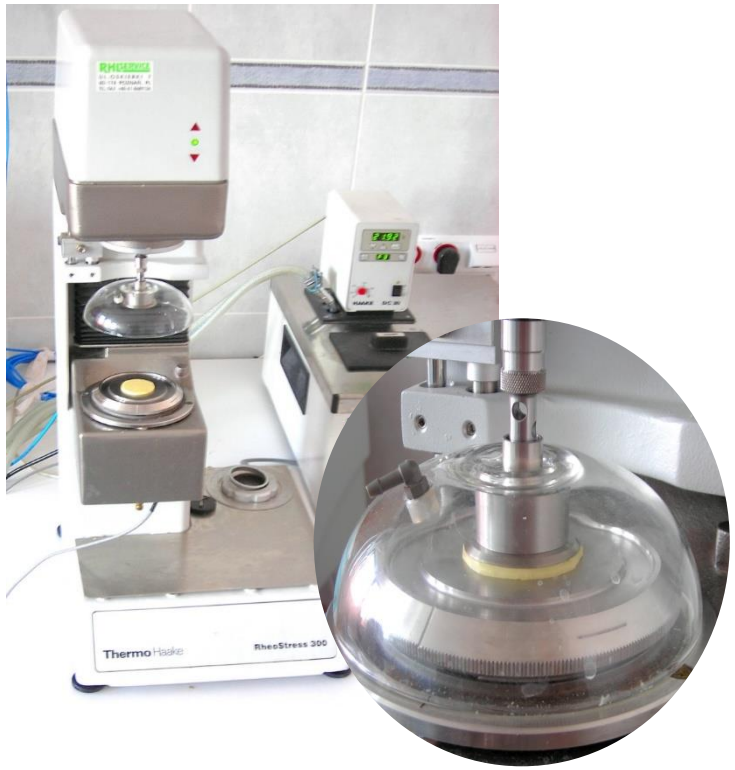
2.3. Penetration test

All measurements were carried out using the TA-XT2i Texture Analyzer (Stable Micro Systems, Godalming, Surrey, UK) according to the protocol described by Fox, McSweeney, Cogan, and Guinee (2017). Processed cheese sauces were penetrated by a 15 mm diameter cylindrical probe to the depth of 28 mm. The penetration rate was 1 mm/s. Processed cheese sauces were evaluated for their hardness and adhesiveness using Texture Expert software. Five measurements were carried out for each of the three replicates.

Table 1
Effect of WPC80 concentration on processed cheese sauces texture attributes obtained on the basis of AC with OCO or AMF.

Oil/Fat	Content of WPC80 [g/100 g]	Texture attributes	
		Hardness (N)	Adhesiveness (J)
AC and OCO	2	$0.11^{a} \pm 0.003$	$3.42^{a} \pm 0.30$
	3	$0.13^{b} \pm 0.005$	$22.88^{b} \pm 0.88$
	4	$0.18^{c} \pm 0.004$	$103.32^{e} \pm 2.51$
	5	$0.20^{d} \pm 0.007$	$142.09^{g} \pm 1.39$
	6	$0.20^{d} \pm 0.006$	$176.94^{i} \pm 0.47$
	7	$0.29^{e} \pm 0.017$	$159.03^{h} \pm 3.67$
	8	$0.18^{c} \pm 0.009$	$62.58^{d} \pm 0.78$
AC and AMF	2	$0.11^{a} \pm 0.009$	$39.38^{c} \pm 0.63$
	3	$0.15^{b} \pm 0.003$	$102.09^{e} \pm 1.39$
	4	$0.15^{b} \pm 0.003$	$112.82^{f} \pm 4.18$
	5	$0.15^{b} \pm 0.001$	$159.12^{h} \pm 7.93$
	6	$0.88^{f} \pm 0.006$	$232.47^{j} \pm 3.67$
	7	$0.93^{g} \pm 0.007$	$384.47^{k} \pm 2.68$
	8	$0.98^{h} \pm 0.15$	$392.69^{l} \pm 1.1$



2.5. Viscoelastic properties

Storage (G') and loss (G'') moduli of cheese sauces were measured applying Kinexus lab+ rheometer (Malvern Panalytical, Cambridge, United Kingdom) using serrated plates (PU40X SW1382 SS and PLS40X S2222 SS, at plate – plate configuration). Measurements were made at 21 °C and frequency of 10 Hz. Results from measurements were computer-registered in the Kinexus Malvern program - rSpace.

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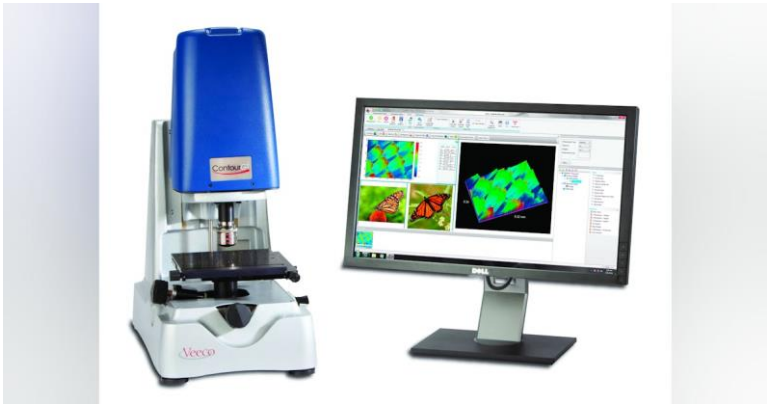
Table 2
Effect of WPC80 on G' and G'' moduli of processed cheese sauces obtained on the basis of AC and OCO or AMF.

Oil/Fat	Content of WPC80 [g/100 g]	G' (Pa) ± SD	G'' (Pa) ± SD
AC and OCO	2	8.57^{a} ± 0.14	4.16^{a} ± 0.30
	3	70.32^{b} ± 1.63	29.77^{b} ± 0.24
	4	1588.68^{d} ± 7.21	597.57^{d} ± 6.95
	5	3367.24^{e} ± 1.34	1141.96^{f} ± 8.61
	6	6140.77^{j} ± 1.33	2329.09^{j} ± 1.31
	7	14820.77^{m} ± 2.84	4986.28^{n} ± 2.65
	8	3905.39^{i} ± 4.76	1254.69^{g} ± 4.12
AC and AMF	2	473.85^{c} ± 8.28	161.78^{c} ± 9.29
	3	3402.15^{f} ± 7.24	1131.78^{e} ± 7.73
	4	3713.49^{g} ± 6.08	1288.45^{h} ± 7.19
	5	3747.69^{h} ± 5.64	1295.75^{i} ± 2.09
	6	7296.25^{k} ± 1.17	3110.98^{k} ± 2.54
	7	7327.2^{l} ± 7.56	3757.19^{l} ± 2.88
	8	7329.46^{l} ± 13.26	3854.62^{m} ± 2.22



foods

MDPI

Article

The Effect of Erythritol on the Physicochemical Properties of Reformulated, High-Protein, and Sugar-Free Macarons Produced from Whey Protein Isolate Intended for Diabetics, Athletes, and Physically Active People

Maciej Nastaj [1,*], Bartosz G. Sołowiej [1], Konrad Terpiłowski [2], Wiesław Kucia [3], Igor B. Tomasevic [4] and Salvador Peréz-Huertas [5]

2.8. Surface Properties of the Obtained Macarons (Roughness, Color Coordinates and Microstructure)

The surface of the obtained macarons was observed using an optical profilometer GT Contour Surface Metrology (Veeco, Tucson, AZ, USA). The surface roughness was calculated using the Vision64 software (Veeco). Color parameters, namely L*: brightness, a*: ±red-green, and b*: yellow-blue, were determined using a computer vision system (CVS); the method was invented and described earlier by Tomasevic et al. [38]. The microstructure was observed using a polarizing optical microscope Eclipse E600Pol (Nikon, Tokyo, Japan) at 40× magnification.

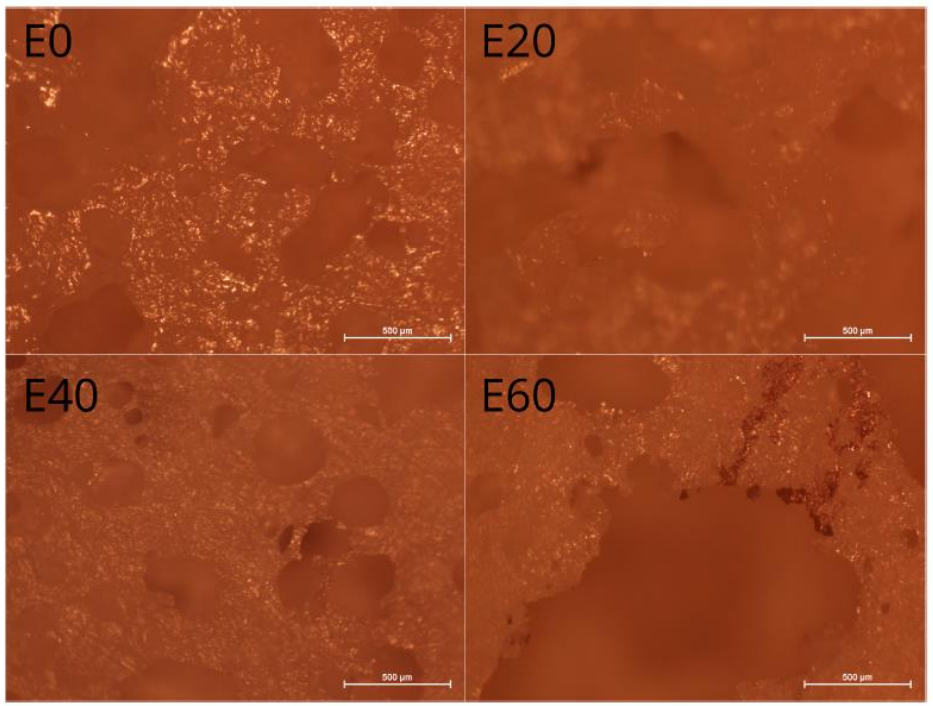


Figure 3. The optical microscope images (magnification 40×) for the obtained macarons.

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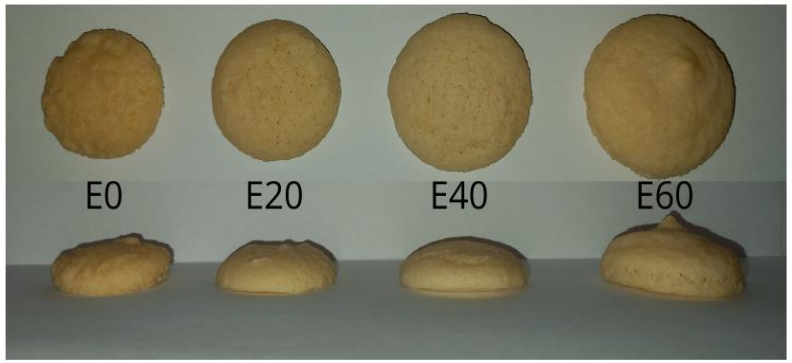

Figure 4. Images of the top views and side profiles of the obtained macarons.

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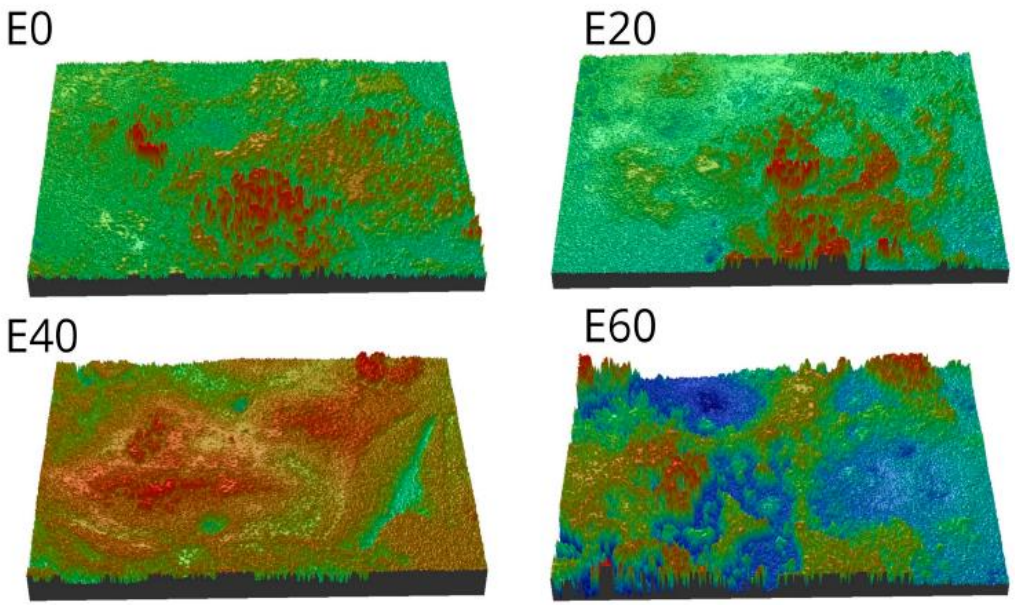

Figure 2. Optical profilometer images (surface 0.9 × 1.3 mm) of the obtained macaron samples. The largest roughness values are represented by the red regions and the smallest by the blue ones.

Table 2. The effect of erythritol on the yield stress (Pa), storage modulus (Pa), loss modulus (Pa), and phase angle (°) values of the macaron batters before solidification.

Sample	τ (Pa)	G′ (Pa)	G″ (Pa)	δ (°)
E0	27.10 ^{c} ± 1.2	1028.33 ^{c} ± 12.02	263.18 ^{b} ± 5.70	14.36 ^{b} ± 0.12
E20	34.40 ^{b} ± 1.7	1379.93 ^{b} ± 7.01	343.56 ^{a} ± 6.13	14.05 ^{c} ± 0.05
E40	40.75 ^{a} ± 2.1	1399.35 ^{a} ± 10.86	347.61 ^{a} ± 5.33	13.98 ^{d} ± 0.02
E60	21.30 ^{d} ± 1.1	716.94 ^{d} ± 9.36	192.62 ^{c} ± 6.44	15.04 ^{a} ± 0.10

The differences among the mean values in the column designated with different letters are statistically significant ($p < 0.05$).

Thank you for your attention!

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