CHANGES IN THE STRUCTURAL STABILITY OF CHESTNUT PUREE DUE TO THE ADDITION OF DIETARY FIBRE

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Abstract
Our work involved the production of spoonable chestnut puree products with different inulin types (FTX, HP, GR, HSI) in order to obtain a spoonable stock. The evaluation of the samples were based on the water activity, dry material content, colour, and rheological properties.

Introduction
Chestnut consumption is particularly widespread and popular in Hungary. Chestnuts can be eaten whole, e.g. as roasted chestnuts, as a popular delicacy at Christmas fairs, but the most common commercial form is quick-frozen puree or quick-frozen paste. Chestnut paste is the mashed chestnut version, which according to the Hungarian Food Guide should not contain added sugar or sweeteners, and is usually used in cakes and various meat dishes. Chestnut purée with added sugar and/or sweeteners is a dessert in its own right [1].
Recently, the largest producer of chestnut products in Hungary has started to produce and market a product which, according to the Hungarian Food Guide, is a chestnut puree, but not quick-frozen, but stored in vacuum packaging in the refrigerator (5-10°C). This product inspired the product development described in this thesis. Inulin, which functions as dietary fibre and prebiotic in the human body, is low in calories and suitable for diabetics. In the food industry, it is mainly used as a thickener in dairy products and as a fat replacer and fat substitute [2, 3]. The chestnut product we have developed has a good digestive effect due to its inulin content, which makes it suitable for a healthy diet and a product that can be eaten as a dessert on its own.

Materials
Basic ingredients needed for the preparation of chestnut puree product were the follows: chestnut paste (Prima Maroni Ltd.), maltitol powder (Paleocentrum Ltd), and FTX, HP? GR? HSI inulin (Orafti Ltd.)

Preparation of chestnut puree products
The ingredients were mixed, and after that stored at 5°C for 48 hours. The ingredients are shown in Table 1.

Table 1. Ingredients of the chestnut puree product

Name of the product	Chestnut paste (%)	Inulin (%)	Maltitol (%)
MControl (MC)	80	0	20
M10GR 10%	80	10	10
M15HSI 5%	80	5	15
M10HSI 5%	85	5	10

Determination of dry material content and water activity

Determination of dry material content of the biscuits was performed by using a MAC-50 rapid moisture analyzer (Radwag Waagen GMBH, Hilden, Germany). To determine the water activity, Novasina, LabMaster-aw equipment was used.

Colour measurements

Colour is a determining factor in the definition of the quality of any food. The colour of the surface of three biscuit samples were also measured with 3 parallels using a Konica Minolta CR400 chromameter. Results were expressed as L*, a*, and b* values. L* is a measure of the brightness from black (0) to white (100), while a* describes the redgreen color (a*> 0 indicates redness, a* < 0 indicates greenness), and b* describes yellow-blue color (b*> 0 indicates yellowness, b* < 0 indicates blueness). To determine the total color difference between two samples using all the three coordinates, the following formula was used [4]:

$$\Delta E^* = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}$$

Rheology measurements

The rheology properties were investigated with the Physica MCR 51 (Anton-Paar) rheometer in oscillation mode using the amplitude sweep method. The oscillation measurements were performed with a plate-plate measuring system, P-PTD 200 type measuring plate, and a PP50/s 50 mm diameter rough surface measuring head. Two parallel measurements were performed for each sample and the data were recorded using Rheoplus v.3.2 software.

Amplitude sweep method was performed with a deflection of 0.01 to 400% (0.0-6mm), a constant 10 rad/s frequency and a constant temperature of +10 °C. During the measurement, 40 measurement points were taken with a time interval of 5 seconds between each point. The storage modulus (G') and loss modulus (G'') were determined as a function of increasing shear stress.G''_0 was determined, the initial loss modulus, and G'_0, the initial elastic modulus, and calculated the end of the linear viscoelastic range, the LVE. The LVE value is the point at which the elastic modulus decreases by 5% from the initial value, i.e. G'_0*0.95. This point includes the value τ_{LVE}, which is the value of shear stress below which the applied force causes the sample to undergo a reversible change in shape, i.e. if the applied force is removed, our test material will return to a state similar to the initial position. In practice, this indicates the stability of the sample at rest. The higher the value of the end of the LVE range, the stronger the structure formed. After the LVE endpoint, the measured storage modulus decreases due to the increasing deformation force and at a certain shear stress, the intersection of the two measured modulus curves (CO) is observed in singles, which marks a kind of yield point, from which point the material behaves as a viscoelastic fluid (G''>G') rather than a viscoelastic solid (G'>G'') [5].

Sensory evaluation

During the sensory evaluation, the judges had to score the biscuits on a 100-point scale. The sensory attributes were given different scores. Texture was 30 points, colour and smell and overall impression 10 points and taste 40 points.

Statistical analysis

For the statistical analysis the mean values were compared by 2-way analysis of variance (ANOVA) when evaluating the sensory attributes of the products ($\alpha = 0.05$). The statistical analysis was carried out using SPSS ver.No.23.

Results and discussion

Table 1 contains the dry material content and water activity. In case of the dry material content and water activity, there are significant differences between the samples (Sig=0.015 and Sig.=0.01). While the water activity of the M15HSI5 sample was almost identical (Sig.=0.83) to the control sample.

Sample	Dry material content (%)	Water activity
MC	44.37	0.764
MGR10	45.1	0.804
M10HSI5	38.17	0.802
M15HSI5	47.53	0.793

Table 1. Dry material content and water activity of the samples

In the rheograms shown in Figure 1, it can be seen, that there is a crossover point for all samples, all samples liquefy during the measurement, which suggests that the addition of maltitol to the chestnut paste weakens its stability and softens its structure.

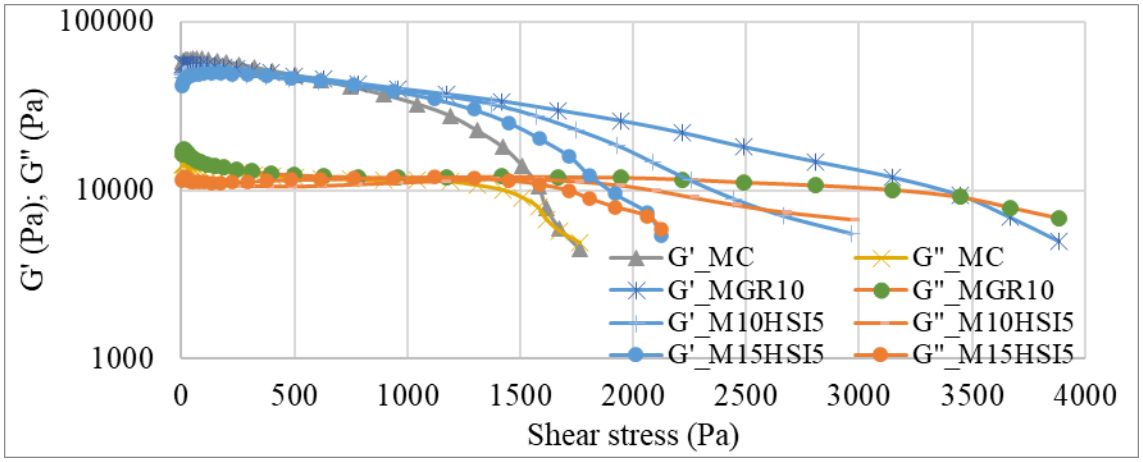

Figure 1. Apmlitude rheograms of the samples

The τ_{CO} values read from the amplitude sweep rheograms are shown in Figure 2. At the lowest shear stress, 1850 Pa was sufficient to force the control sample to flow, followed by the M15HSI5 sample, which flowed near 1940, then the M10HSI5 sample, and finally the MGR10 sample, which was the most stable, requiring a shear stress of 3820 Pa. Based on these results, the control sample and the M15HSI5 sample were the softest and easiest to lubricate.

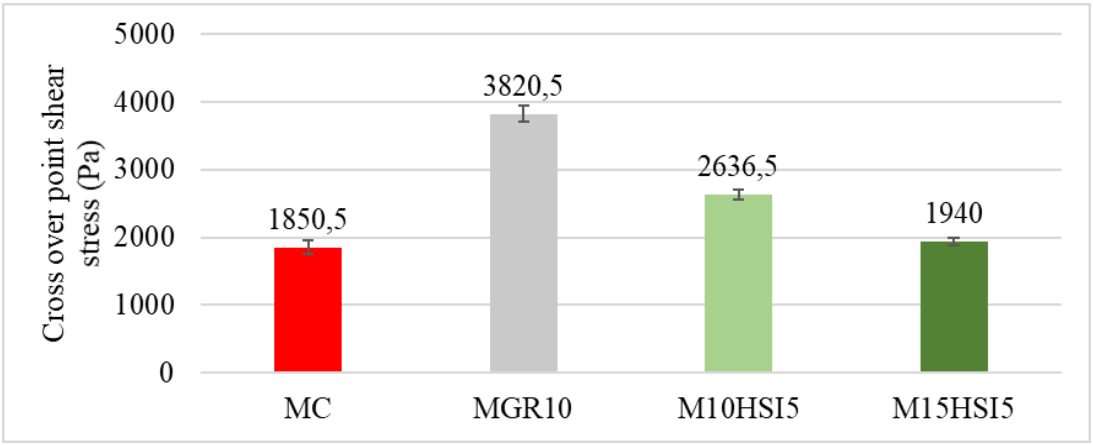

Figure 2. CO point values of the samples

Colour factors were examined. It can be seen that the addition of maltitol makes the samples uniformly darker (Figure 3.)

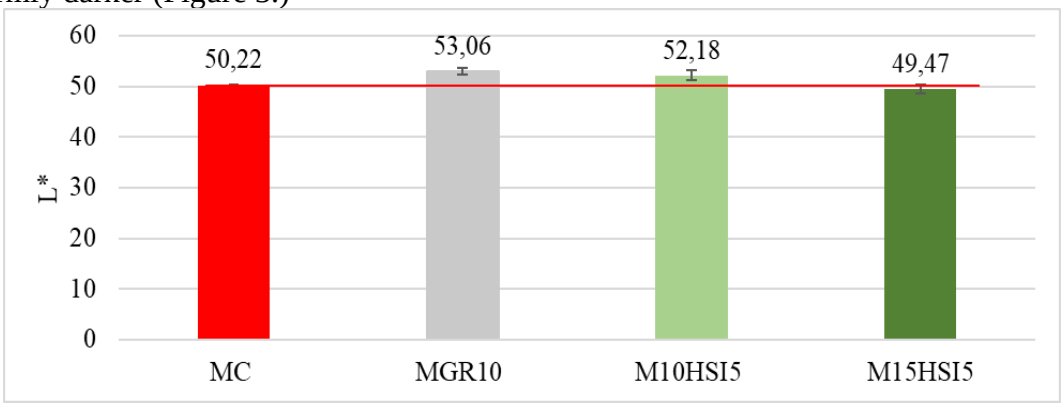

Figure 3. L* value of the samples

The most similar sample to the control sample is M15HSI5, the only one that does not show a significant difference (Sig.=0.22) compared to the control sample. MGR10 and M10HSI5 were significantly lighter than the control.

In case of the sensorial evaluation, it can be say, that the MC sample and the samples containing HSI inulin were considered by the judges to be of adequate consistency or too soft for a spoonable dessert (Figure 4). The consensus was that Prima Maroni's product and the MGR10 sample were too hard for a spoonable dessert.

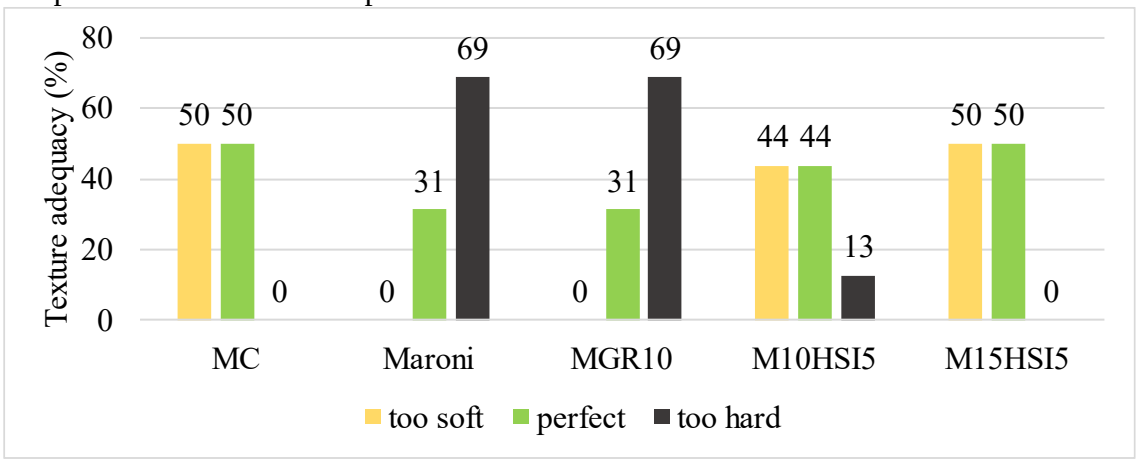

Figure 4. Texture adequacy (%) of the sample

Conclusions

The results of the organoleptic evaluation confirmed my instrumental measurements, thus the sample containing 15% maltitol and 5% HSI inulin was the best overall, with the right sweetness, no unpleasant side flavours and the consistency for a spoonable chestnut dessert.

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