TEXTURAL, FLOW AND SENSORY PROPERTIES OF FIVE "FRUZELINA" WITH SOUR CHERRIES

Paulina Pająk, Teresa Fortuna, Irena Bojdo-Tomasiak

ABSTRACT

Gel with sour cherries called "Fruzelina" is a new product in the Polish market widely used in food industry as a decorative element or filling for pastries, as an ingredient in fruit desserts, as an additive to ice creams, whipped cream and waffles. The cherry gels are the product prepared using different types of chemically modified starches. Starch is an additive used to ensure rich and short texture and high viscosity of "Fruzelina". Food texture and viscosity may be measured by senses and instrumentally. Because of fact that sensory analysis is time consuming and very costly, it is easier and cheaper to determine food properties, especially their texture and flow behaviour by appropriate mechanical tests.

The aim of this work was to study the rheological behavior of five cherry gels and evaluate the correlation between textural, flow and sensory properties of these gels measured instrumentally and by human senses.

The back extrusion test has been found to be applicable to study the textural properties of cherry gels. There was high positive correlation between gel texture measured by senses and texture parameters measured in back extrusion test. Similar high correlation was identified for consistency coefficient K obtained in Ostwald de Waele model and gel texture assessed by sensory panel. It was found that values of sensory parameters such as taste and odour decreased as the rheological parameters increased. High negative correlations were observed in these cases. Therefore, instrumental measurements can be alternative for more expensive sensory methods.

Keywords: cherry gel, texture, flow properties, sensory analysis

INTRODUCTION

Gel with sour cherries called "Fruzelina" is a new product in the Polish market used as a decorative element or filling for pastries, as an ingredient in fruit desserts, as an additive to ice creams, whipped cream and waffles. "Fruzelina" is obtained from whole sour cherries in the amount of no less than 60% of total product weight, and of the starch gel containing natural fruit juice. Sucrose (20%), citric acid and potassium sorbate are the other ingredients in fruit gels. "Fruzelina" are preserved by pasteurization in cans. One of the most important attributes of semisolid food products, which is the main reason of consumer choice, is their texture and viscosity. Good rheological properties are achieved by addition of starch pastes. Chemically modified starches are often used in fruit fillings as texture improvers, thickening agents, replacers for pectin and hydrocolloids **(Saijilata & Singhal, 2005)**. For many years, interest has been shown in correlations between texture measured by the senses and texture measured instrumentally **(Hill et al., 1995)**. Unfortunately, sensory analysis is time consuming and very costly, therefore it is easier and cheaper to measure food quality, especially its texture and flow properties, by instrumental methods.

The aim of this work was to study the rheological behavior of five cherry gels prepared using different types of waxy maize and cassava modified starches (acetylated distarch adipates and hydroxypropylated distarch phosphates) and correlation between textural, flow and sensory properties of these gels measured instrumentally and by the sensory panel.

MATERIAL AND METHODS

Five "Fruzelina" with sour cherries were prepared according to the same recipe in Prospona Ltd Fruit and Vegetable Processing in Nowy Sącz, Poland. Gels were made by using different types of starch at the same concentration (5% d. m.) as following:

- product 1 (P1) contained waxy maize starch: C*Tex 06214 - acetylated distarch adipates (Cargill – Cerestar in Bielany Wrocławskie, Poland),
- product 2 (P2) contained waxy maize starch: Thermflo - hydroxypropylated distarch phosphate,
- product 3 (P3) contained waxy maize starch: National 67-0021 - acetylated distarch adipates,
- product 4 (P4) contained cassava starch: National Frigex HV - hydroxypropylated distarch phosphate,
- product 5 (P5) contained cassava starch: Thickflo - acetylated distarch adipates.

Product P2, P3, P4 and P5 were supplied by National Starch & Chemical in Manchester, Great Britain.

The analysis of the gels involved determination of textural properties using back extrusion test. Textural properties were made using texturometer EZ Test (Schimadzu, Japan). 40 g of the gel samples (after cherry removal) were weighed in a cylindrical container having an inner diameter of 32 mm. The plunger consisted of a stainless steel rod having a diameter of 30 mm and height of 5 mm. The samples were tested at plunger speed 25 $mm.min^{-1}$. The rod was immersed in the sample to 30 mm in depth. Three magnitudes were determined during measurements: work made by rod [N·mm], maximum force [N] and mean force [N] necessary to squeeze gel sample through the gap between container and rod.

The flow properties were determined with a rotational rheometer Rheolab MC1 (Physica Meβtechnic GmbH, Germany) with a Z3 DIN concentric cylinders geometry (external diameter – 27.12 mm, internal diameter – 25.00 mm). Measurements were made at 25°C. The sample of gel (after cherry removal) was loaded in a gap between two cylinders and was allowed to equilibrate for 10 min. The software US 200 Data Manager (Physica Meβtechnic GmbH, Germany) was employed to obtain the rheological parameters. Flow curves were plotted according to following program: increasing rate of shear from 0 to 300 s^{-1} within 10 min. The shear stress of analyzed gels was measured as a function of shear rate.

Table 1. The results of back extrusion test of five cherry gels.

Fruit gel	Work [N·mm]	Maximum force [N]	Mean force [N]
P1 (C*Tex 06214)	176.01[a]	6.53[a]	5.87[a]
P2 (Thermflo)	238.54	9.17	8.08
P3 (National 67-0021)	180.86[a]	7.50[a]	6.03[a]
P4 (National Frigex HV)	93.82[b]	3.78[b]	3.12[b]
P5 (Thickflo)	98.58[b]	3.84[b]	3.26[b]

*Within columns, values followed by the same small letters do not differ significantly at p=0.05.

The Ostwald de Waele model ($\tau = K \cdot \dot{\gamma}^n$) was tried to determine the rheological behavior of gels, where τ is the shear stress (Pa), $\dot{\gamma}$ is the shear rate (s^{-1}), K is the consistency coefficient (Pa s^n), n is the flow behavior index (dimensionless) **(Kembłowski, 1973; Schramm, 1998)**.

The sensory analysis of fruit gels were carried out by 13-person sensory panel trained according to **Polish Standard (1998a, 1998b, 1996)**. The five-point scale method (1–poor quality, 5–excellent quality) was used **(Baryłko-Pikielna, 1975)**. Appearance, colour, taste, odour, and texture were evaluated by panelists. Appearance, colour, and texture were determined apparently for cherry and gel. The established coefficients of importance (c. i.) for the above attributes were the following: 0.1 (fruit appearance), 0.1 (gel appearance), 0.05 (fruit colour), 0.05 (gel colour), 0.1 (odour), 0.15 (fruit texture), 0.15 (gel texture), 0.3 (taste).

Statistical analysis was carried out using Microsoft Excel software. The one-way analysis of variance was used at p=0.05 (Fisher's test) to determine significant differences among cherry gels. At least duplicate measurements were made for each cherry gel samples.

RESULTS AND DISCUSSION

The results of back extrusion test are presented in Table 1. Several parameters were calculated in the back extrusion test, such as work (calculated as area under peak), maximum and mean forces necessary to squeeze gel through the gap between container and rod. The type of used starch significant affected the values of work made by rod as well as maximum and mean forces of cherry gels. The highest values of these magnitudes exhibited product P2 thickened by adding waxy maize starch – Thermflo (238.54 N·mm, 9.17 N and 8.08 N respectively). This gel had rich, thick and short texture. Slightly less thick texture showed gel P1 and P3. No statistically significant differences in texture parameters were found between Product P1 and P3 (also prepared by using waxy maize starches – C*Tex and National 67-0021). Only cherry gels made with using cassava starches (P4 and P5), exhibited almost twice lower values of work, maximum and mean forces measured instrumentally. Their texture was of long and loose types.

Rheological parameters fitted to Ostwald de Waele model are shown in Table 2. The type of starch used to obtain thick texture and high viscosity had significant influence on the rheological parameters. All products were non-Newtonian fluids and had pseudoplastic behavior, which confirms the other observations concerning fruit fillings **(Ahmed et al., 2007; Grigelmo-Miguel & Martin-Belloso, 2000; Maceiras, 2007; Pelegrine et al., 2002)**. Consistency coefficient K (which is the measure of apparent viscosity) was the highest for gel P1 thicken by adding waxy corn starch C*Tex) and then for gels P2 and P3. The smallest K values exhibited samples P4 and P5 with cassava starches (1.20 and 6.55 [Pa s^n], respectively).

The n values ranged between 0.39-0.62 which indicate shear thinning nature of the fruit gels (if n is <1, the fluid is shear thinning) ***[Clark, 2006]***. As the behavior indexes indicate pseudoplasticity was larger for P1, P2 and P3

Table 2. Rheological parameters of Ostwald de Waele model

Fruit gel	Ostwald de Waele model		
	K [Pa•s^n]	n	R^2
P1 (C*Tex 06214)	52.46	0.39	0.992
P2 (Thermflo)	43.19[a]	0.42[a]	0.992
P3 (National 67-0021)	43.77[a]	0.42[a]	0.995
P4 (National Frigex HV)	1.20[b]	0.62	0.999
P5 (Thickflo)	6.55[b]	0.55	0.997

*Within columns, values followed by the same small letters do not differ significantly at p=0.05

Table 3. Results of sensory analysis of fruit gels by 5-point scale method (mean values after augmentation by coefficients of importance and standard deviations).

Quality factor		Coefficient of importance (c.i.)	P1	P2	P3	P4	P5
Appearance	gel	0.1	0.46	0.44	0.41	0.48	0.50
	cherry	0.1	0.42	0.43	0.38	0.46	0.48
Colour	gel	0.05	0.24	0.25	0.23	0.22	0.22
	cherry	0.05	0.23	0.24	0.22	0.23	0.23
Odour		0,1	0.43	0.44	0.43	0.45	0.47
Texture	gel	0.15	0.70	0.72	0.68	0.57	0.58
	cherry	0.15	0.60	0.59	0.59	0.65	0.65
Taste		0.3	1.25	1.06	1.04	1.32	1.36
Total score		1.0	4.33	4.16	3.98	4.37	4.48

samples which means that the samples P4 and P5 tend to behave as a Newtonian fluid.

On the basis of the results of sensory analysis (tab. 3) it was stated that the examined gels exhibited good quality. The total scores for all samples were above 3.98. The worst quality in 5-point scale of all the products was represented by P3 gel, mainly due to the lowest notes for its appearance and taste.

According to **Hill et al. (1995)** liquid and semisolid foods, e.g. weak gels, are relatively easy to evaluate by

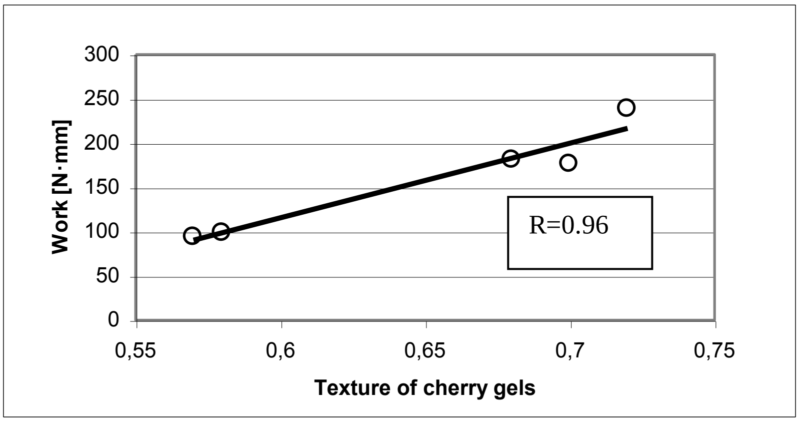

Fig. 1. Correlation between texture measured by sensory panel and work measured instrumentally.

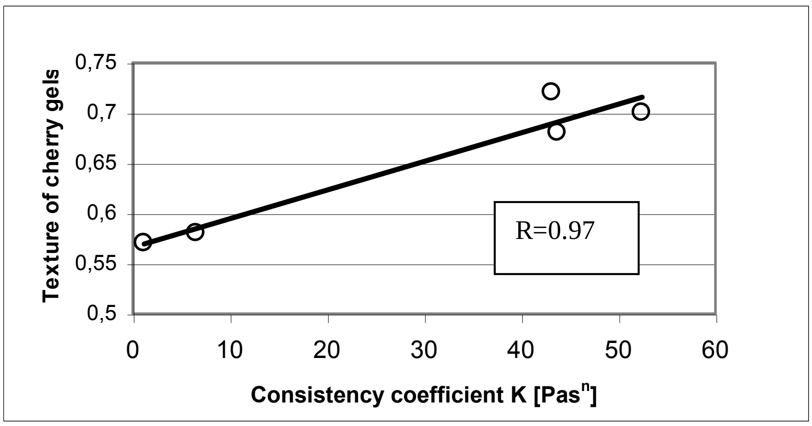

Fig. 2. Correlation between texture measured by sensory panel and work measured instrumentally.

fundamental rheological methods. They stated that appropriate rheological parameters (such as steady shear viscosity or complex viscosity measured in oscillation) give good positive correlation with sensory thickness. Moreover they showed that there is interaction between other sensory parameters such as flavour (both taste and odour) and texture measured instrumentally. Intensity of perceived sweetness and flavour decreases as the thickness of the product increases. As would be expected in this paper there was a high positive correlation between texture and rheological parameters measured instrumentally and texture measured by sensory panel (coefficients of correlation were very high, R>0.96). Some of the examples are shown in fig. 1 and 2. Opposite relationship was observed in the case of sensory parameters (taste and odour) and consistency coefficient *K* of Ostwald de Waele's model or texture parameters from back extrusion test With increasing values of sensory parameters decrease in *K* values was observed. Correlations were negative R= -0.72 and R= -0.85 for taste and odour respectively. Similar behaviour was found between back extrusion test parameters and taste assessed by senses. With increasing values of sensory parameters, a decrease in work made by the rod during back extrusion test (R= -0.86) was stated.

CONCLUSION

The back extrusion test has been found to be applicable to study the textural properties of cherry gels. There was high positive correlation between texture measured by senses and instrumentally. The relationship between apparent viscosity (determined as consistency coefficient *K*) and texture assessed by sensory panel was similar to the above. These results suggest that the texture of gels can be predicted instrumentally without using expensive and time consuming sensory analysis. It was found that values of sensory parameters such as taste and odour decreased as the rheological parameters increased. High negative correlations were observed in these cases.

REFERENCES

AHMED, J., RAMASWAMY, H. S., SASHIDHAR, K. C. 2007. Rheological characteristics of tamarind *(Tamarindus indica L.)* juice concentrates. In *LWT*, 2007, 40, 225-231.

BARYŁKO-PIKIELNA, N. 1975. Zarys analizy sensorycznej żywności. WNT, Warszawa 1975.

CLARK J. P. 2006. Everything flows. In *Food Technology*, 2006, 11, 68-70.

GRIGELMO-MIGUEL, N., MARTIN-BELLOSO O. 2000. The quality of peach jams stabilized with peach dietary fiber. Eur. In *Food Research Technology*, 2000, 211, 336-341.

HILL, M. A., MITCHELL, J. R., SHERMAN P. A. 1995. The relationship between the rheological and sensory properties of a lemon pie filling. In *Journal of Texture Studies*, 1995, 26, 457-470.

KEMBŁOWSKI, Z. 1973. Reometria płynów nienewtonowskich. Wydawnictwa Naukowo-Techniczne, Warszawa, 1973.

MACEIRAS, R., ÁLVAREZ E., CANCELA, M. A. 2007. Rheological properties of fruit purees: Effect of cooking. In *Journal of Food Engineering*, 2007, 80, 763-769.

PELEGRINE, D. H., SILVA, F. C., GASPARETTO, C. A. 2002. Rheological Behavior of Pineapple and Mango Pulps. In *Lebensm.-Wiss. u.-Technol.*, 2002, 35, 645–648.

POLISH STANDARD PN-ISO 3972 (1998a). Sensory analysis. Methodology. Method of investigating sensitivity of taste.

POLISH STANDARD PN-ISO 6658 (1998b). Sensory analysis. Methodology. General guidance.

POLISH STANDARD PN-ISO 8586-1 (1996). Sensory analysis. General guidance for selection, training and monitoring of assessors. Part 1. Selected assessors.

SAJILATA, M. G., SINGHAL, R. S. 2005. Specialty starches for snack foods. In *Carbohydrate Polymers*, 2005, 10, 131-151.

SCHRAMM, G. 1998. Reologia. Podstawy i zastosowania. Ośrodek Wydawnictw Naukowych PAN, 1998, Poznań.

Acknowledgements
The scientific research was realized within a framework of supervisor grant nr N N312 208236 financed from budget of Ministry of Science and Higher Education.

Contact address:
Paulina Pająk, PhD, Department of Food Analysis and Quality Assessment, University of Agriculture, Balicka Street 122, 30-149 Krakow, Poland, e-mail: p.pajak@ur.krakow.pl