JAP&T
TPA-Timisoara

Available online at http://journal-of-agroalimentary.ro

Journal of Agroalimentary Processes and Technologies 2011, *17*(1), 25-29

Journal of Agroalimentary Processes and Technologies

Rheological characterization of snail Pâté. I. Uniaxial compression

Dana Carolina Crisan[1], Ioan Danciu[1], Constantin Mateescu[2*]

[1] *"Lucian Blaga" University of Sibiu, Faculty of Agricultural Sciences, Food Industry and Environmental Protection, Bd-ul. Victoriei, Nr.10, Sibiu, 550024, România*
[2] *Banat University of Agricultural Sciences and Veterinary Medicine, Dept. Food Processing Technology, 119 Calea Aradului, 300645 Timisoara, Romania*

Received: 11 January 2011; Accepted: 15 March 2011

Abstract

Three sorts of snail pâté were prepared. In the fist two sorts different quantities of a vegetal protein (biogel) is put in. In the third sort, the content of bacon was substituted with vegetal oil. The influence of temperature on the rheological characteristics of snail pâté was studied in this paper. The rheological characteristics of snail pâté were derived from uniaxial compression tests. The following rheological characteristics were calculated from compression curves: Young modulus, firmness, critical stress and compression energy. As is expected, the Young modulus decreases with increase of temperature. Both temperature and the content of sorts, influences the values of the above parameters. The Young modulus was calculated tacking into account both Cauchy strain and Hencky strain. To determine the firmness and critical stress from compression curves, Hencky strain was used to draw these curves.

Keywords: snail pâté, rheology, uniaxial compression, temperature influence.

1. Introduction

Fatty Human beings have eaten snails for thousands of years and nowadays snails are a common food consumed by millions of people worldwide, especially in some European countries such as France [1]. Snails are considered a delicacy in many countries and are a staple part of the diet in parts of Asia where red meat and poultry are scarce sources of protein. Many varieties of edible snails are used. However, the Moroccan snail (*Helix aspersa*) is especially favored in Western European and Mediterranean countries and *Helix pomatia* in Central and Alpine Europe [2]. Snail meat (H. aspersa) contains little fat and is rich in many nutrients that are important to human health. Therefore, snail meat can be included in the feed of individuals under dietary restrictions.

Snail meat (*H. Aspersa maxima*) is an adequate protein source with low lipid content in its essential fatty acid composition (linoleic and linolenic acids) and polyunsaturated fatty acids with more than 20 C atoms (0.45-2.66%), indicating that the use of this food is suitable for patient diet, irrespective of total lipid content [3]. Having a low content of lipids and high content of proteins, meat snail is similarly with fish meat.

Helix pomatia (*H. Pomatia*) type land snail, which is included in Gastropoda class of Mollusca phylum, is consumed widely particularly in countries such as France, Belgium, Germany and Italy. Land snail consumption is in increasing demand due to its high quality protein, low fat, high calcium, magnesium and iron content [4].

Corresponding author: *e-mail:* c.mateescu@usab-tm.ro

Fat is an important ingredient of processed meat products and has a major influence on the binding properties, tenderness, juiciness, mouth feel and overall appearance. In addition, fat contributes to the rheological properties of these products [5]. Nowadays, there is an increasing demand for foodstuffs with lower fat content. However, the reduction of fat in meat products or its replacement with a more unsaturated fat might affect their technological or sensory characteristics [6], mainly in products in which fat is one of the major components of the formulae, such as frankfurters, sausages, beef patties or liver pâtés. Moreover, the higher risk of oxidation in products enriched with unsaturated oils must be considered [7]. Owing to their composition, lipid oxidation is one of the primary mechanisms associated with deterioration of their quality. Therefore, antioxidants have become a useful group of food additives because they help to maintain the organoleptic quality of pâtés by avoiding rancidity [8].

There are same references on rheology of ham pâté [5] and of pork liver pâté [9] by textural profile analysis. In addition, rheology of liver pâté had been evaluated by penetration tests [10] and the consistency at 23°C of the refrigerated pâtés by compression tests [7]. The similar studies on snail pâté are not signaled yet. Three new recipes for snail pâté are proposed in this paper, snail meat being considered a substitute of other type of meat used in classical pâté. In this paper, we try to characterize the rheology of some variants of snail pâté by compression tests realized at three different temperatures.

2. Materials and methods

The ingredients for preparing pâté are shown in Table 1. Cans of three types of pâté have been prepared in a specialized laboratory from a SME.

Table 1. Ingredients composition (g/100g) of prepared pâté

	I	II	III
Snail meat	31.4	31.7	36.9
Bacon	9	9.1	-
Chicken liver	9	9.1	13.85
Boiled pig skin	4.5	4.5	4.6
Vegetal oil	-	-	13.85
Water	35.9	36.3	23.1
Aromatized herbs	2.25	2.27	2.31
Dehydrated onion	0.9	0.9	0.9
Potato starch	2.7	2.7	2.7
Carrageenan	0.18	0.18	0.18
Salt	1.44	1.45	1.48
Biogel (vegetal protein)	2.7	1.81	-

The fist two types have different content of soy vegetal protein (biogel). The last type has less water, more chicken liver and snail meat. In addition, it has not any bacon and vegetal protein.

Cans with snail pâté were storage at 4-6°C in refrigerator. For rheological characterization of snail pâté, uniaxial compression had been used. The measurements were made at three different temperatures: 8°C, 14°C, and 21°C respectively. Using a cork borer, cylindrical specimens of snail pâté were prepared. The specimens had a diameter of 20 mm and their height was adjusted at 20-25 mm.

The temperature of samples had been measured with a portable Hanna Instruments K-thermocouple thermometer HI 935005. To determinate Young modulus, by using a compression apparatus JTL Janz the specimens were uniaxial compressed between parallel-lubricated plates at 6 mm $\cdot$ min^{-1}. To calculate Young modulus from compression curves, both Hencky and Cauchy strains [11] we took into consideration. In addition, firmness and critical stress was determinate from compression curves. The ORIGIN program had been used for regression and plotting results.

3. Results and Discussion

The compression curves of the sorts from table 1 at the three studied temperatures, drawn with Hencky strain, are presented in figures 1 – 3. The Young modulus was determined as the slope of the straight line (the initial slope) of the compression curves for Hencky (ε_H) and respectively Cauchy (ε_C) strains less than 0.15 as shown in figure 4 [11]. Firmness and critical stress were taken from compression curves, firmness being the stress corresponding at a Hencky strain of 0.25, and critical stress (σ_c) as could be seen in figure 4. The numbers of experimental points used to draw the compression curves are between a minimum of 124 (for curve 3, figure 2) and a maximum of 273 points (for curve 1, figure 3). The limits of the linear region of the curves were found to be less than a Hencky strain of 0.2. The value of the coefficient of determination for the linear regression between stress and Hencky, respectively Cauchy strain for the linear region was over 0.985. Energy to compress the pate samples at 30% of the initial heights was calculated from area under the stress – Cauchy strain curve. The compression energy was calculated in kJ $\cdot$ m^{-3}.

The stress–strain relationships of samples from snail pâté indicated the non-linear response, as in the case of fish-meat gels [12,13], as could be observed from figures 1-3. For all three sorts, until to ε_H < 0.15-0.2, the compression is linear. It means that the network structure of fish–meat gel became very stable at the compression strain of 0.2 [12]. At higher values of Hencky strain, the compression becomes nonlinear. In the samples for sort II (table 1) where the content of vegetal protein is 1.8% at Hencky strains greater than strain corresponding to critical stress, for the curves at 8 and 14°C the stress values decrease (figure 2) and at 21°C remains constantly. These decreases correspond to the fissures appearance. It is possible that the content of biogel (vegetal protein) to be less than optimal value that assures the gelling of the entire mass of pâté, or the biogel could not be uniformly distributed in pâté. In the samples from sort I with 2.7% biogel, was not observed ruptures in the samples at all studies temperatures and on the entire domain of compression. It is possible this content of biogel to assure the gelling of the entire mass of pâté. In addition, the viscous properties of the sample materials might be strong with the increase of strain. The increase of viscous properties and local rupture of structure and weakling of the network structure with the increase of strain might be led to the changes in the internal structure of sample materials [14]. In the samples from sort III, which no content of biogel but with around of 14% of vegetal oil did not appeared fissures even if ε_H > 1 (figure 3). Tacking into consideration the good fluidity [15] of the used vegetable oil the homogeneity of the samples was very well assured in the preparation process of snail pâté.

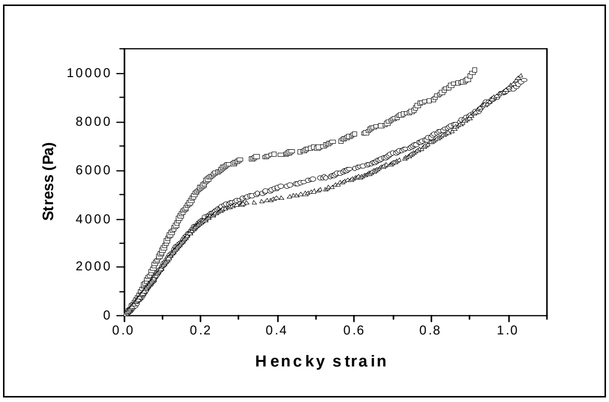

Figure 1. Compression curves at three temperatures for snail pâté (Sort I from the table 1). □ - 8°C; ○ - 14°C; Δ - 21°C;

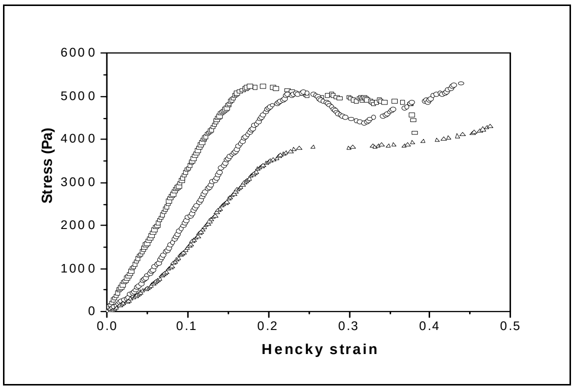

Figure 2. Compression curves at three temperatures for snail pâté (Sort II from the table 1). □ - 8°C; ○ - 14°C; Δ - 21°C;

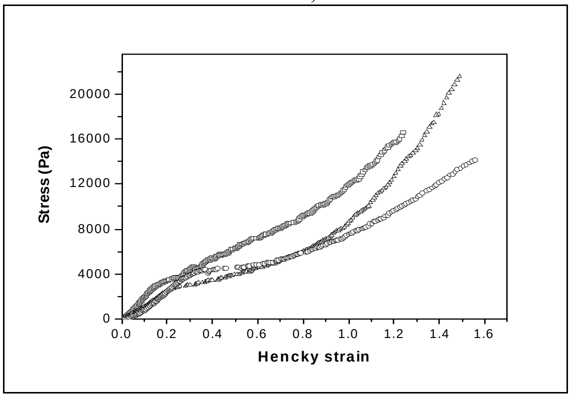

Figure 3. Compression curves at three temperatures for snail pâté (Sort III from the table 1). □ - 8°C; ○ - 14°C; Δ - 21°C;

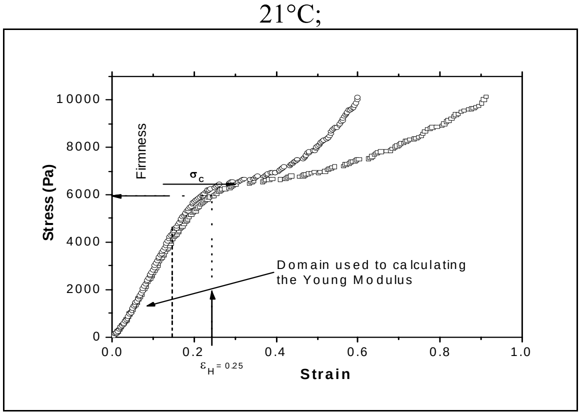

Figure 4. The same compression curve with Cauchy strain (□), and Hencky strain (○) respectively. The calculation for Young modulus, firmness and critical stress

The influence of the temperature on the calculated and determined parameters from the compression curves are presented in the table 2. As can be observed the temperature influences the values of all parameters: Young modulus, firmness, the critical stress and the compression energy.

Because $\varepsilon_H > \varepsilon_C$ [11] the Young modulus calculated with Hencky strain are less than the calculated values with Cauchy strain.

The values of Young modulus could be connected with the content of vegetal protein, the sort with a greater content of biogel (sort I) having a Young modulus greater than sort II.

For all sorts of snail pâté the Young modulus decreases with the increasing of temperature.

This decrease is nonlinear one. In addition, the presence of vegetable oil in the sort III, as substitute of bacon, contributes to decrease of compression energy.

Table 2. The rheological parameters of studied snail pâtés calculated or obtained from the uniaxial compression curves

Sort	Temperature (°C)	Young modulus (Pa)		Firmness (Pa)	Critical stress (Pa)	Compression energy (kJ · m^{-3})
		Hencky strain	Cauchy strain			
I	8	30300±560	33010±420	6340	6450	4.18
	14	22100±320	24080±60	4750	4690	3.04
	21	19930±1910	23665±810	4550	4550	2.92
II	8	27870±7300	31010±8980	4350	3130	3.79
	14	16160±2580	18890±3630	3850	4450	3.13
	21	10490±920	11350±820	2990	2800	2.30
III	8	29590±2590	32100±2000	5050	5260	2.76
	14	27620±4120	30700±4250	5070	5090	2.01
	21	22400±3850	25450±4600	3800	3800	1.83

4. Conclusion

The rheological parameters of different sorts of snail pâté, as Young modulus, firmness, critical stress, compression energy, are influenced both the temperature and the composition of pâté. The values of these parameters decrease with the increase of temperature. The increase of the content of vegetal protein contributes to the greater values of the above parameters. In the presence of vegetal oil, the smallest values for compression energy were attained.

References

1. Jess, S.; Marks, R.J., Effect of temperature and photoperiod on growth and reproduction of Helix aspersa var. Maxima, *Journal of Agricultural Science*, **1998**,*130*, 367–372.
2. ***, *Microbial Ecology of Food Commodities*, Capt. 6 in: *Microorganisms in Foods*, Second edition, Kluwer Academic / Plenum Publishers, New York, Boston, Dordrecht, London, Moscow, 2005
3. Milinsk, M.C.; Padre, R.G.; Hayashi, C.; de Oliveira, C.C.; Visentainer, J.V.; de Souza, N.E.; Makoto Matsushita, Effects of feed protein and lipid contents on fatty acid profile of snail (Helix aspersa maxima) meat, *Journal of Food Composition and Analysis*, **2006**, *19*(2-3), 212–216; doi:10.1016/j.jfca.2004.09.011
4. Temelli, S.; Dokuzlu, C.; Cem Sen, M.K., Determination of microbiological contamination sources during frozen snail meat processing stages, *Food Control*, **2006**, *17*(1), 22–29; doi:10.1016/j.foodcont.2004.08.004
5. Viana, F.R.; Silva, V.D.M.; Delvivo, F.M.; Bizzotto, C.S.; Silvestre, M.P.C., Quality of ham pâté containing bovine globin and plasma as fat replacers, *Meat Science*, **2005**, *70*(1), 153–160; doi:10.1016/j.meatsci.2004.12.013
6. Jimenez Colemenero, F., Relevant factors in strategies for fat reduction in meat products, *Trends in Food Science & Technology*, **2000**, *11*(2), 56–66, doi:10.1016/S0924-2244(00)00042-X
7. Martin, D.; Ruiz, J.; Kivikari, R.; Puolanne, E., Partial replacement of pork fat by conjugated linoleic acid and/or olive oil in liver pâtés: Effect on physicochemical characteristics and oxidative stability, *Meat Science*, **2008**, *80*(2), 496–504, doi:10.1016/j.meatsci.2008.01.014
8. Pinho, O.; Ferreira, I.M.P.L.V.O.; Oliveira, M. B.P.P.; Ferreira, M. A. Quantification of synthetic phenolic antioxidants in liver pâtés, *Food Chemistry*, **2000**, *68*(3), 353-357, doi:10.1016/S0308-8146(99)00205-8
9. D'Arrigo, M.; Hoz, L.; Cambero, I.; Lopez-Bote, C.J.; Pin, C.; Ordóñez, J.A., Production of n-3 fatty acid enriched pork liver pâté, *LWT - Food Science and Technology*, **2004**, *37*(6), 585-591, doi:10.1016/j.lwt.2003.11.006

10. Estevez, M.; Ventanas, S.; Cava, R., Physicochemical properties and oxidative stability of liver pâté as affected by fat content, *Food Chemistry*, **2005**, *92*(3), 449–457, doi:10.1016/j.foodchem.2004.08.014
11. Steffe, J.F., *Rheological Methods in Food Processing Engineering*. 2nd ed., Freeman Press, East Lansing, MI 48823, USA, 1996
12. Dimitreli, G.; Thomareis, A.S. Texture evaluation of block-type processed cheese as a function of chemical composition and in relation to its apparent viscosity, *J. of Food Engineering*, **2007**, *79*(4), 1364–1373; doi:10.1016/j.jfoodeng.2006.04.043
13. Kong, C. S., Effects of lubrication and sample dimensions on compression property of fish–meat gels, *Food Research International*, **2005**, *38*(6), 673–679
14. Kong, C. S.; Ogawa, H.; Iso, N. Compression Properties of Fish-Meat Gel as Affected by Gelatinization of Added Starch, *J. Food Sci*., **1999**, *64*(2), 283-286; doi: 10.1111/j.1365-2621.1999.tb15883.x
15. Santos, J.C.O.; Santos, I.M.G.; Souza, A.G. Effect of heating and cooling on rheological parameters of edible vegetable oils, *Journal of Food Engineering*, **2005**, *67*(4), 401–405; doi:10.1016/j.jfoodeng.2004.05.007