



HAL
open science

Impact of mastication on the gastric digestion of frankfurters : case of elderly

Thierry Sayd, Marie-Agnès Peyron, Samuel Viet, Véronique Santé-Lhoutellier

► To cite this version:

Thierry Sayd, Marie-Agnès Peyron, Samuel Viet, Véronique Santé-Lhoutellier. Impact of mastication on the gastric digestion of frankfurters : case of elderly. 62. International Congress of Meat Science and Technology (ICoMST), Aug 2016, Bangkok, Thailand. hal-01602806

HAL Id: hal-01602806

<https://hal.science/hal-01602806>

Submitted on 3 Jun 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - ShareAlike 4.0 International License

IMPACT OF MASTICATION ON THE GASTRIC DIGESTION OF FRANKFURTERS : CASE OF ELDERLY

Sayd T.¹, Peyron MA², Viet S¹. & Santé-Lhoutellier V^{1*}.

¹QuaPA 63122 Saint Genes Champanelle, France

²UNH, 63122 Saint Genes Champanelle, France

*Corresponding author email: veronique.sante@clermont.inra.fr

Abstract – This work was designed to evaluate the impact of deficient food oral processing and aging digestive conditions on a model food: frankfurters.

Food boluses were prepared for normal mastication or deficient chewing by programming a mastication simulator (AM2). Gastric digestion was simulated using a dynamic in vitro digester (DIDGI®) of adult and elderly physiological conditions. Lipids, proteins and peptides kinetic release were assessed by Infrared spectroscopy. We observed a low impact of chewing on normal gastric digestion, mainly compensated by the activity of gastric enzymes and the acidic conditions. However, in elderly digestive conditions, a delay in release of macronutrients with a less extent occur. This study can be considered as a proof of concept with a purpose for developing specific food for elderly, adapted to their ability for oral processing and digestive physiology.

Key Words – chewing, digestion, meat products

I. INTRODUCTION

Many developed countries show changes in population demographics with an increasing proportion of elderly and therefore an emerging set of specific nutritional needs for that population. The population of elderly with higher care needs is associated with a higher prevalence of malnutrition and health status. Chewing efficiency declines strongly with aging. Mouth is the first compartment of the digestive tract and is designed to prepare the food bolus suitable to be safely swallowed [1] once adequately comminuted and lubricated by

saliva. In addition with aging less acidification occurs in the stomach and gastric enzymes often show reduced secretion [2]. In a recent international cohort study, it was recommended 1.0 to 1.5 g protein/kg body weight/day for individuals older than 65 years compared to 0.8 g protein/kg body weight/day for healthy adults with proteins as 15-20 % of total energy intake [3]. Meat and meat products are considered as a good source of proteins, highly digestible [4, 5]. However, there is a lack of information about the impact of combining oral deficiency and digestive conditions of elderly on this nutritional potential of meat products. The aim of the study was to evaluate this combination on a model food: frankfurters.

II. MATERIALS AND METHODS

Frankfurters processing

Pork frankfurters were prepared with pig muscle (*Triceps brachii*) and fat (backfat and throat fat) obtained from a local market. Sodium nitrite, lactose, spices, freeze-dried pig plasma). Prior to the cutting step, visible fat and connective tissue were trimmed from the meat, and lean meat and fat were separately ground through a 4.5 mm plate and stored at 0°C ± 1°C. Minced meat was added into a chilled bowl cutter and homogenized for 1 min. Then sodium nitrite, spices and lactose were added and homogenized for 1 min. The plasma solution and crushed ice were then added and the mixture was homogenized for another minute. Finally, the fat was added. Then all ingredients were mixed until a final temperature of 12°C. Each meat batters were stuffed by a piston stuffer into a 22-24 mm diameter sheep gut. Sausages were hand-linked at nearly 10 cm intervals. They were pre-

cooked in a steam room for 15 min at 50°C, and then 60 min at 60°C. Then they were steamed using a water-bath at 67°C during 40 min. Finally sausages were cooled in an ice water-bath for 1 h. They were vacuum-packed and stored at 4°C ± 1°C until use.

Masticatory experiments

In vitro masticatory experiments were performed with a masticatory apparatus [5, 6] programmed to produce food boluses of granulometric properties similar to those observed *in vivo* for this kind of food matrix. In these conditions, boluses were collected after 27 masticatory cycles which was the mean number of masticatory cycles observed *in vivo* in normal mastication to prepare a ready-to-swallow bolus of Frankfurter or after 9 masticatory cycles observed *in vivo* in elderly mastication. After *in vitro* mastication, the food bolus was immediately collected for *in vitro* digestion.

In vitro digestion

A dynamic digester available at QuaPA (DIDGI®, INRA Clermont Ferrand, France) was used to perform digestions on the two samples (adult bolus and elderly bolus) in triplicate. The digestion system and the software (SToRM: stomach regulation and monitoring) were previously described for infant digestion by [8]. The half-time of gastric emptying used in the present study was set at 95 min. An exponential equation as described by [9] was used to monitor the gastric emptying and the coefficient (β) has been set up at 2. The acidification curve occurring in the gastric compartment was controlled by the software SToRM (see below).

0100090000038d00000002001c000000000040
0000003010800050000000b020000000050000
000c029606de0a040000002e0118001c000000fb
021000070000000000bc020000000010202225
3797374656d00767017f513dc5d2d000ee3c7768
001cc7668bef613e85d2d00040000002d0100000
40000002d0100000400000020101001c000000
fb02a4ff000000000009001000000004400022
43616c69627269000000000000000000000000
00000000000000000000000040000002d0101
00040000002d010100040000002d01010005000
000090200000002d000000320a560000000100
04000000000e40a98062000360005000000090

200000002040000002d010000040000002d0100
000300000000000

Compared to adult digestive conditions, the pepsin quantity was reduced by 40% and lipase by 80% in elderly digestive conditions. Samples were collected at 30, 60, 90, 120 and 150 min of digestion for further analysis.

Proteins, peptides and lipids assessment

Protein concentration was measured using Bradford method. For peptides, TCA was added (final concentration 15%), after centrifugation (4000g) were collected and analyzed at 1650 cm⁻¹ using mid infrared spectroscopy (Direct detect, Merck Millipore). Lipids were analyzed with the same method at 2840-2870 cm⁻¹.

Statistical analysis

Two-way analysis of variance (ANOVA) was applied to proteins, peptides and lipids data using Statistica Software (v12.0). The effect of digestion time was included as repeated measure. The mean values are presented with the standard error of mean (SD), and the effects were found significant at $p \leq 0.05$.

III. RESULTS AND DISCUSSION

Chewing efficiency

The kinetics of proteins release from the frankfurters was measured in the gastric compartment after normal (M3/3) and deficient (M1/3) mastication (Fig 1). The maximum of protein release was obtained more rapidly with normal mastication (M3/3)

0100090000038d00000002001c000000000040
0000003010800050000000b020000000050000
000c029606de0a040000002e0118001c000000fb
021000070000000000bc020000000010202225
3797374656d00767017f513dc5d2d000ee3c7768
001cc7668bef613e85d2d00040000002d0100000
40000002d0100000400000020101001c000000
fb02a4ff000000000009001000000004400022
43616c69627269000000000000000000000000
00000000000000000000000040000002d0101
00040000002d010100040000002d01010005000
000090200000002d000000320a560000000100
04000000000e40a98062000360005000000090
200000002040000002d010000040000002d0100

00030000000000

The peptides release traduced the protein hydrolysis occurring in the stomach. No difference was observed whatever the mastication ability (Fig 2). Moreover a gradual increase was noted, showing an independent evolution from protein release.

0100090000038d00000002001c0000000000040
0000003010800050000000b0200000000050000
000c029606de0a040000002e0118001c000000fb
021000070000000000bc0200000000010202225
3797374656d00767017f513dc5d2d000ee3c7768
001cc7668bef613e85d2d00040000002d0100000
40000002d0100000400000020101001c000000
fb02a4ff00000000000090010000000004400022
43616c69627269000000000000000000000000
00000000000000000000000000000000000000
0004000002d010100040000002d01010005000
0000902000000020d000000320a560000000100
04000000000e40a98062000360005000000090
200000002040000002d010000040000002d0100
00030000000000

Lipids release was limited at the beginning of the gastric digestion and a significant step was observed at 90 min in both mastication conditions (Fig 3).

0100090000038d00000002001c0000000000040
0000003010800050000000b0200000000050000
000c029606de0a040000002e0118001c000000fb
021000070000000000bc0200000000010202225
3797374656d00767017f513dc5d2d000ee3c7768
001cc7668bef613e85d2d00040000002d0100000
40000002d0100000400000020101001c000000
fb02a4ff00000000000090010000000004400022
43616c69627269000000000000000000000000
00000000000000000000000000000000000000
0004000002d010100040000002d01010005000
0000902000000020d000000320a560000000100
04000000000e40a98062000360005000000090
200000002040000002d010000040000002d0100
00030000000000

Chewing efficiency slightly impacted the kinetics of the nutrients studied.

Adult and elderly digestion

The kinetics of proteins release from the

frankfurters was measured in the gastric compartment after adult or elderly digestive conditions (Figure 4). A delay in proteins release was observed the elderly digestive conditions. The maximum was obtained between 60 and 90 min for adult while it was after 120 min for the elderly digestive conditions.

0100090000038d00000002001c0000000000040
0000003010800050000000b0200000000050000
000c029606de0a040000002e0118001c000000fb
021000070000000000bc0200000000010202225
3797374656d00767017f513dc5d2d000ee3c7768
001cc7668bef613e85d2d00040000002d0100000
40000002d0100000400000020101001c000000
fb02a4ff00000000000090010000000004400022
43616c69627269000000000000000000000000
00000000000000000000000000000000000000
0004000002d010100040000002d01010005000
0000902000000020d000000320a560000000100
04000000000e40a98062000360005000000090
200000002040000002d010000040000002d0100
00030000000000

The peptides release traduced the protein hydrolysis occurring in the stomach. A gradual increase was noted in both conditions but with a slower rate of 15% in elderly digestive conditions (Fig 5). The rate of peptides release was 6.5 mg/h and 5.5 mg/h for adult and elderly digestive conditions, respectively. Moreover the quantity of peptides release in elderly digestive conditions was reduced by 20%.

0100090000038d00000002001c0000000000040
0000003010800050000000b0200000000050000
000c029606de0a040000002e0118001c000000fb
021000070000000000bc0200000000010202225
3797374656d00767017f513dc5d2d000ee3c7768
001cc7668bef613e85d2d00040000002d0100000
40000002d0100000400000020101001c000000
fb02a4ff00000000000090010000000004400022
43616c69627269000000000000000000000000
00000000000000000000000000000000000000
0004000002d010100040000002d01010005000
0000902000000020d000000320a560000000100
04000000000e40a98062000360005000000090
200000002040000002d010000040000002d0100
00030000000000

Lipids release increased drastically between 60 and 90 min for adult digestive conditions while a gradual increase was observed for elderly

digestive conditions (Fig 6).

0100090000038d00000002001c0000000000040
0000003010800050000000b0200000000050000
000c029606de0a040000002e0118001c000000fb
021000070000000000bc020000000010202225
3797374656d00767017f513dc5d2d000ee3c7768
001cc7668bef613e85d2d00040000002d0100000
40000002d0100000400000020101001c000000
fb02a4ff00000000000090010000000004400022
43616c69627269000000000000000000000000
000000000000000000000000040000002d0101
00040000002d010100040000002d01010005000
0000902000000020d000000320a560000000100
040000000000e40a98062000360005000000090
200000002040000002d010000040000002d0100
00030000000000

This study enabled coupling chewing / gastric digestion and characterizing the release of compounds of interest in the chyme. Little information is available in the literature on the coupling chewing / digestion and bioavailability of macronutrients because these analyzes require specific designs. Few studies have been done on milk and the release of proteins and lipids, after oral processing, gastric and intestinal steps [10, 11]. Both studies went up to the identification of peptides and lipids released. However this topic has not been treated for elderly, which limits us in comparison with the work done. The use of in vitro models to study the mastication and digestion is an advantage, because analyzes are less difficult than in the experiment in vivo.

IV. CONCLUSION

The study allowed to combine two main processes of digestion on a model food Frankfurter. The release of macronutrients was strongly impacted by the aging digestive conditions. However, one can speculate that elderly with deficient chewing ability will have a delay in the gastric digestion of proteins and less availability of peptides and amino acids, potentially in situations of deficiencies. As far as we know, this study is the first one taking in account the oral processing and digestive physiology of elderly and the potential cumulative effect. This concept will be applied for developing specific food for elderly.

ACKNOWLEDGEMENTS

The authors thank Qualiment® for fundings (QualigrasPhy project 2014-2017)

REFERENCES

1. Woda, A., Mishellany, A., & Peyron, M. A. (2006). The regulation of masticatory function and food bolus formation. *J Oral Rehabil*, 33(11), 840-849
2. Feldman, M. C. B. M. A., KE, Huet, BA;, Lee, E. (1996). Effects of Aging and Gastritis on Gastric Acid and Pepsin Secretion in Humans: A Prospective Study. *Gastroenterology*, 110, 1043-1052.
3. Bauer, J., Biolo, G., Cederholm, T., Cesari, M., Cruz-Jentoft, A. J., Morley, J. E., Phillips, S., Sieber, C., Stehle, P., Teta, D., Visvanathan, R., Volpi, E., & Boirie, Y. (2013). Evidence-based recommendations for optimal dietary protein intake in older people: a position paper from the PROT-AGE Study Group. *J Am Med Dir Assoc*, 14(8), 542-559.
4. Bax, M.-L., Aubry, L., Ferreira, C., Daudin, J.-D., Gatellier, P., Remond, D., & Sante-Lhoutellier, V. (2012). Cooking Temperature Is a Key Determinant of in Vitro Meat Protein Digestion Rate: Investigation of Underlying Mechanisms. *Journal of Agricultural and Food chemistry*, 60(10), 2569-2576.
5. Bax, M.-L., Buffiere, C., Hafnaoui, N., Gaudichon, C., Savary-Auzeloux, I., Dardevet, D., Sante-Lhoutellier, V., & Remond, D. (2013). Effects of Meat Cooking, and of Ingested Amount, on Protein Digestion Speed and Entry of Residual Proteins into the Colon: A Study in Minipigs. *Plos One*, 8(4).
6. Woda, A., Mishellany-Dutour, A., Batier, L., François, O., Meunier, J.P., Reynaud, B., Alric, M., Peyron, M.A. (2010). Development and validation of a mastication simulator. *Journal of Biomechanics* 43: 1667-1673.
7. Mishellany-Dutour, A., Peyron, M.A., Croze, J., François, O., Hartmann, C., Alric, M., Woda, A. (2011). Comparison of food boluses prepared in vivo and by the AM2 mastication simulator. *Food Quality and Preference* 22: 326-331
8. Menard, O., Cattenoz, T., Guillemain, H., Souchon, I., Deglaire, A., Dupont, D., & Picque, D. (2014). Validation of a new in vitro dynamic system to simulate infant digestion. *Food Chem*, 145, 1039-1045.

9. Elashoff, JD., Reedy T., Meyer JH (1982). Analysis of gastric emptying data. *Gastroenterology*, 83: 1306-1312
10. Gervais R., Gagnon F., Kheadr E., Van Calsteren M., et al.(2009). Bioaccessibility of fatty acids from conjugated linoleic acid enriched milk and milk emulsions studied in a dynamic in vitro gastrointestinal model. *Int Dairy* 19: 574-581
11. Kopf-Bolan K., Schwander F., Gijs M., Vergeres G., Portmann R., Egger L. (2012) Validation of an In vitro digestive system for studying macronutrient decomposition in Humans. *Journal of Nutrition*