



## Bolus quality and food comfortability of model cheeses for the elderly as influenced by their texture



L. Lorieau<sup>a</sup>, C. Septier<sup>b</sup>, A. Laguerre<sup>b</sup>, L. Le Roux<sup>a</sup>, E. Hazart<sup>c</sup>, A. Ligneul<sup>c</sup>, M.-H. Famelart<sup>a</sup>, D. Dupont<sup>a</sup>, J. Floury<sup>a</sup>, G. Feron<sup>b</sup>, H. Labouré<sup>d,\*</sup>

<sup>a</sup> INRA – UMR, STLO Science & Technology of Milk & Eggs, INRA Agrocampus, France

<sup>b</sup> INRA – UMR CSGA, Centre des Sciences du Goût et de l'Alimentation, France

<sup>c</sup> Lactalis Recherche et Développement, 35240 Retiers, France

<sup>d</sup> Agrosup Dijon, France

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### ABSTRACT

The aim of this study was to examine the influence of the texture of dairy products on bolus properties and food comfortability as perceived by elderly persons.

Four cheese models identical in terms of their nutritional composition but different by the type of texture (Soft, Hard, Processed and Whipped) were developed to resemble market cheese. Study was performed with a panel of 38 elderly persons without dental impairment but with variable rate of saliva flow. The time of chewing required to form the bolus was measured. The rheological properties of the bolus obtained were studied as well as the quantity of saliva incorporated. Food comfortability was assessed by means of a questionnaire asking about in-mouth comfort, bolus formation, pain, and perceived texture and flavor.

Results showed that food comfortability was positively correlated to the ease of forming the bolus which depended on the food texture. Thus, the bolus formed with the Whipped product which required more saliva, was harder than the other three products and so judged the least comfortable. This product was characterized by a dry and sticky texture. On the other hand, the Soft and Processed products led to a softer food bolus that was more easily formed, and thus were judged as more comfortable. Their textures were perceived as soft, fatty and melting.

This work highlights the importance of considering food bolus formation and related properties when looking for the link between food product characteristics and the enjoyment of eating in the case of the elderly population.

### 1. Introduction

In 2015, 12.3% of the world population were over 60 years old, and this percentage is expected to double by the year 2050. Indeed, it is estimated that this proportion of the population will reach 21.5% in 2050 (Aguilera & Park, 2016). Nevertheless, the challenge is not aging, but healthy aging.

It is commonly assumed that sensory impairments and difficulties in masticating and swallowing occurred with age, and that they negatively affect the diet of older people, both in terms of quality and quantity (Schwartz, Vandenberghe-Descamps, Sulmont-Rossé, Tournier, & Feron, 2017). Older people perceive a lower flavor intensity than younger adults and they are less sensitive to flavor changes and taste intensity levels (Doets & Kremer, 2016). However, such changes in food perception do not reduce the food liking amongst the elderly (Kremer,

Bult, Mojet, & Kroeze, 2007). However, when it comes to oral capacity, aging induces changes in the oral physiology with a decrease of the muscular and bite forces, an increase of the tooth loss (Mioche, Bourdiol, & Peyron, 2004) and a decrease of 38% of the salivary flow (Vandenberghe-Descamps et al., 2016). These impairments lead to an increase of mastication time (Mioche et al., 2004) which in turn affects food choices and dietary intakes (Walls & Steele, 2004).

In this context, food formulation is expected to reduce eating difficulties and produce pleasant food for the elderly. Texture is an important sensory attribute in determining quality and consumer acceptability of food. Furthermore, Devezeaux de Lavergne, van de Velde, van Boekel, and Stieger (2015) confirmed that oral processing is key to dynamic texture perception. Some research has shown that a food is judged difficult to eat when the bolus is difficult to form, which is especially the case with hard products (Laguna & Sarkar, 2016). In

\* Corresponding author.

E-mail address: [helene.laboure@inra.fr](mailto:helene.laboure@inra.fr) (H. Labouré).

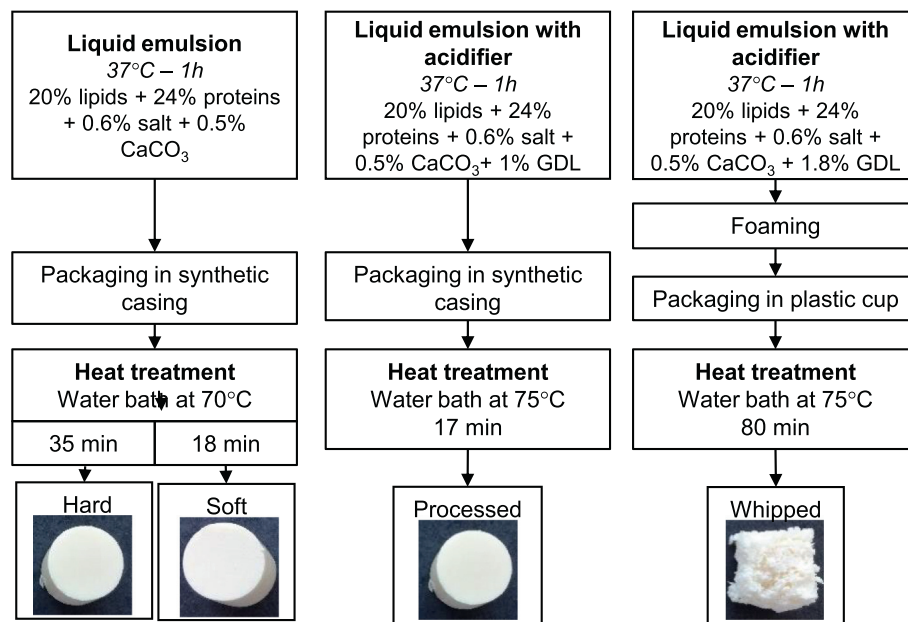


Fig. 1. Manufacturing process of the four cheese models.

general, hard foods require more chewing cycles and greater masticatory forces to be swallowing (Chen, 2009). Moreover, to develop foods for elderly persons that are easy to eat and swallow, it is important to not only consider product characteristics, but also the corresponding food bolus texture properties. Recently, concepts of food comfortability or eating difficulty have been proposed. Food comfortability concept has been developed specifically by and for elderly people (Vandenbergh-Descamps, Labouré, Septier, Feron, & Sulmont-Rossé, 2017). It is a multi-dimensional concept including the bolus formation perception based on attributes linked to oral capacity (teeth and saliva), texture, flavor and pain sensations. This concept is complementary to the “perceived difficulty” which consists principally of the ranking of eating difficulty (from least difficult to most difficult) and its link to changes of bolus properties (hardness, brittleness, inhomogeneity, etc. ...) in the mouth in young adults (Laguna & Sarkar, 2016) or to an eating capability score (based on hand gripping force, tongue pressure, biting force, and hand dexterity) in elderly people (Laguna, Hetherington, Chen, Artigas, & Sarkar, 2016).

To our knowledge, studies on “oral comfort” or “perceived difficulty” have not been conducted yet in the specific case of dairy products tasted by elderly people. Indeed, previous studies focused on either sensory perceptions or bolus formation, or were performed on model gels or foods significantly different from each other in terms of texture and composition. Moreover, these studies were not necessarily conducted on elderly population (Drago et al., 2011; Foster, Woda, & Peyron, 2006; Hayakawa et al., 2014; Laguna et al., 2016; Park, Kim, Lee, & Park, 2017).

However, dairy products are a relevant solution to improve the nutritional status of the elderly and to prevent sarcopenia and bone fragility. Indeed, older people start to lose weight from around age 65, mainly due to a progressive loss of skeletal muscle mass, a process which is known as sarcopenia. Thus, older adults require an increased daily protein intake (around 1.0 to 1.3 g/kg body weight) relative to younger people (0.8 g/kg body weight) (Bauer et al., 2013). Nutritional studies on older people have demonstrated that whey proteins stimulated postprandial muscle protein accretion more effectively than caseins (Pennings et al., 2011). Furthermore, whey proteins also appear to have some anabolic benefits beyond their contents of essential amino acids (Bauer et al., 2013). Therefore, it seems reasonable to develop food products for elderly people that will provide nutritionally balanced proteins.

Physiological dysfunctions and specific nutritional needs occurring with aging require a specific food development that enhances nutritional intakes whilst maintaining the enjoyment of eating. In this context, the main objective of the current study was to evaluate the sensory characteristics of four cheese models adapted to the nutritional needs of elderly but that were also comfortable to eat. Four cheese models identical in terms of their nutritional composition but different by the type of texture (Soft, Hard, Processed and Whipped) were developed. The sensory characteristics of these products were evaluated by a panel of elderly people. The relationships between mastication, food bolus properties and comfortability of mouthfeel were subsequently explored and discussed. The long-term goal is to develop new dairy products adapted to the specific needs of the elderly.

## 2. Material and methods

### 2.1. Cheese models

#### 2.1.1. Composition

The cheese models prepared were based on an emulsion of whey proteins with cream which was heated to induce a gel. This emulsion contained 24% (w/w) of whey proteins (95% whey proteins, Pronativ®, Lactalis Ingrédients, Bourgbarré, France), 20% (w/w) of fat provided by cream (Crème Fleurette 30% Casino, Saint Etienne, France) and 0.6% (w/w) of NaCl (European Salt Company, Hannover, Germany). The pH of the cheese models was adjusted with gluconodeltalactone (GDL) (Roquette, Lestrem, France) depending on the formulation of the subsequent product (Fig. 1).

#### 2.1.2. Preparation of the cheese models

A range of processing conditions were used in order to obtain the four defined cheese textures from the same source material (Fig. 1). These products are subsequently referred to as “Soft”, “Hard”, “Processed” and “Whipped”. To avoid the effect of product taste on the food comfortability, the products were not flavored and had the same taste. The liking ratings validated the neutral appreciation of the products (the scores were ranged from 1 to 7. The average liking score was  $3.1 \pm 1.5$ ,  $3.5 \pm 1.3$ ,  $4.5 \pm 1.1$ , and  $4.6 \pm 1.2$  for Whipped, Hard, Soft and Pasty products respectively).

In all cases, the source dairy ingredients were first mixed 1 h at 37 °C using a blender (Thermomix TMS, Vorwerk, France). For the Hard,

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