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Impact of blade tenderization, marinade and cooking temperature on oral comfort when eating meat in an elderly population

Mathilde Vandenberghe-Descamps, Claire Sulmont-Rossé, Chantal Septier, Claire Follot, Gilles Feron*, Hélène Labouré

Centre des Sciences du Goût et de l'Alimentation, AgroSup Dijon, CNRS, INRA, Univ. Bourgogne Franche-Comté, F-21000 Dijon, France

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ABSTRACT

Several studies demonstrated that oral health impairment, such as tooth loss or a decrease in salivary flow might lead elderly people to reduce their meat intake. The present study assessed the impact of culinary processes liable to improve meat texture and smooth down meat oral processing, in order to fulfil the oral capacities of elderly people. Four culinary processes were selected: cooking bag, blade tenderizer, marinade and low-temperature cooking. A panel of 40 elderly participants with good and poor dental status were asked to assess 5 chicken breast samples, 5 roast beef samples and 4 beefsteak samples prepared according to different process conditions by using an "oral comfort" questionnaire. Results highlighted the fact that oral impairment may alter food bolus formation as well as texture perception while eating meat in elderly people. Furthermore, they revealed that easy-to-do culinary processes may improve meat tenderness and juiciness as well as smooth down food bolus formation, in particular for the roast beef.

1. Introduction

With aging, oral health impairments can occur and lead to difficulties in masticating, humidifying food with saliva or even swallowing foods. Oral health degradation such as tooth loss (Auvray, Doussin, & Le Fur, 2003; Hoffmann et al., 2006), wearing of dentures (Asakawa, Fueki, & Ohyama, 2005), decrease in muscle strength (Goodpaster et al., 2006; Peyron, Blanc, Lund, & Woda, 2004), lack of saliva (Vandenberghe-Descamps et al., 2016) and impaired swallowing (Humbert & Robbins, 2008; Tracy et al., 1989) can alter food consumption (Cousson et al., 2012; Geissler & Bates, 1984; Joshipura, Willett, & Douglass, 1996; Lee et al., 2004; Marcenes, Steele, Sheiham, & Walls, 2003; Muñoz-González et al., 2017; Sura, Madhavan, Carnaby, & Crary, 2012). Regarding meat consumption, Lee et al. (2004) highlighted that edentate participants had lower intake in hard-to-chew foods, including fried chicken and beef, compared to dentate elderly participants. Another study led by Marcenes, Steele, Sheiham, and Walls (2003) showed that edentulous elderly people had significantly greater difficulty eating well-done steaks compared to dentate elderly participants. However, consuming an appropriate amount of meat according to the body's needs, thereby having a sufficient intake of proteins, is essential for preventing muscle loss and in the end malnutrition in elderly people (Beasley, Shikany, & Thomson, 2013; Paddon-Jones, Short, Campbell, Volpi, & Wolfe, 2008). Therefore, it is of crucial importance to develop meat products that have an adapted texture for the elderly's masticatory ability.

Many studies have investigated the improvement of meat texture through the use of culinary processes (Aktaş, Aksu, & Kaya, 2003; Burke & Monahan, 2003; Davis, Smith, & Carpenter, 1977; Hayward, Hunt, Kastner, & Kropf, 1980; Jeremiah, Gibson, & Cunningham, 1999; Oreskovich, Bechtel, McKeith, Novakofski, & Basgall, 1992; Savell, Smith, & Carpenter, 1977). Among the techniques are blade tenderization and marinating, which are largely represented in the literature. Cooking temperature is also known to have an impact on meat characteristics.

Blade tenderization consists of perforation of the meat with sharp edged blades that are closely spaced to cut muscle fibers (Pietrasik & Shand, 2004) and is one of the most effective interventions currently used to ensure tenderness (King et al., 2009). Many authors have reported that one or two passages depending on the meat category and muscle type were sufficient to increase meat tenderness and overall meat palatability (King et al., 2009; Obuz, Akkaya, Gök, & Dikeman, 2014; Pietrasik, Aalhus, Gibson, & Shand, 2010). Obuz, Akkaya, Gök, and Dikeman (2014) have for example studied the impact of a blade tenderizer on meat characteristics using shear force evaluation and sensory analysis. The authors showed a decrease in the shear force value and an increase in the tenderness assessment with the use of a blade tenderizer passed two times on the meat. Regarding marinade,

* Corresponding author at: INRA-CSGA, 17 rue Sully, 21065 Dijon, France.
E-mail address: gilles.feron@inra.fr (G. Feron).

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many authors have highlighted its impact on meat palatability. Made of red wine, citrus juice or even soy sauce, the effects of marinade on meat texture characteristics have been largely explored (Aktaş, Aksu, & Kaya, 2003; Burke & Monahan, 2003; Kim et al., 2013; Oreskovich, Bechtel, McKeith, Novakofski, & Basgall, 1992). Kim et al. (2013) have for example investigated the impact of a soy sauce marinade on meat tenderness using rheological measurements. The results showed a decrease in shear force with increasing soy sauce concentration in the marinades. Finally, cooking temperature is known to have an impact on mechanical properties, as soluble collagen in meat increases with greater cooking temperature and soluble protein decreases when cooking temperature increases (Davey & Gilbert, 1974; Murphy & Marks, 2000). Furthermore, several authors have shown an increase in cooking loss, *i.e.* the amount of meat juice exudate during cooking, with increasing cooking temperature (Barbanti & Pasquini, 2005; Bouton & Harris, 1972).

Even though these processes seem promising to soften and/or moisten meat products, they have never been tested for acceptability in an elderly population, members of which are known to be less sensitive to texture perception than younger adults (Conroy, O' Sullivan, Hamill, & Kerry, 2017). Consequently, the aim of the present experiment was to test culinary processes and ask an elderly panel to assess oral comfort when eating the samples. In addition, the elderly's oral health was characterized to investigate the impact of oral health on meat acceptability. To this end, we asked elderly people to rate the oral comfort of 3 meat products prepared according to different process conditions using the "oral comfort" questionnaire developed in a previous study (Vandenberghe-Descamps, Labouré, Septier, Feron, & Sulmont-Rossé, 2017).

2. Materials and methods

2.1. Participants

Two groups of 20 older adults (≥65 years old) were recruited, one group with a good dental status (10 women and 10 men; age mean: 72.8 yo; age range: 66–87) and one group with a poor dental status (11 women and 9 men; age mean: 74.7 yo; age range: 67–89). According to Leake, Hawkins, and Locker (1994), the number of functional units was used to characterize elderly people's dental status. A functional unit was defined as a pair of posterior antagonist teeth that had at least one contact area during chewing. The number of functional units was evaluated by asking the participants to chew 1–2 cycles on 200-mm thick articulating paper; the number of teeth on the mandibular arch that had at least one color mark provided the number of functional units. Elderly people with at least 7 functional units and not wearing a removable denture were considered as having a good dental status; elderly people with 4 or less functional units and possibly wearing a removable denture were considered as having a poor dental status. The other recruitment criteria were the following: older than 65 years old, living at home, no acute pathological episodes neither at the time of the experiment nor in the recent past, a score of at least 24 on the mini mental state evaluation (MMSE) (Folstein, Folstein, & McHugh, 1975). An interview was carried out with each volunteer to ensure that they met the inclusion criteria. In parallel, the resting and stimulated salivary flows of every volunteer were measured by instructing the participant to spit out the saliva into a pre-weighed screw-cap cup every time they felt like swallowing. The measurement of resting salivary flow was over a period of 10 min and the measurement of stimulated salivary flow lasted 5 min during which the participants were asked to masticate a piece of pre-weighted parafilm while spitting saliva. The salivary flow rate was expressed in ml/min, assuming that 1 g of saliva corresponded to 1 ml.

2.2. Products

Three meat products were chosen for the present study: chicken breast, roast beef and beefsteak. All the products were provided by a butcher and each meat was provided from the same batch. Four culinary processes were selected: cooking bag (Albal®), blade tenderizer, marinade and low-temperature cooking. These processes were chosen because they are easy to implement in everyone's kitchen (they do not need expensive or complex devices) and/or because they proved to have a positive impact on meat tenderness and/or juiciness in the scientific literature. As it was not possible to ask the elderly participants to taste all the possible combinations made with these four culinary processes, preliminary tests were conducted *i.* to select the most promising processes and/or combinations of processes, and *ii.* to set up the protocol for each culinary processes. For these preliminary tests, several assays were achieved and evaluated through two physical measurements: the shear force evaluation, which was demonstrated to be correlated with meat tenderness (Obuz, Akkaya, Gök, & Dikeman, 2014; Pietrasik, Aalhus, Gibson, & Shand, 2010) and water content. Shear force, which corresponds to the force necessary to cut the sample, was measured by using a Warner-Bratzler (V-shaped cutting blade) attachment positioned on an electronic testing machine (ttc® TA.XT plus) at a crosshead speed of 2 mm/s. Water content was evaluated by weighing a

Table 1
For each product, characterization of the samples.

Sample	Culinary processes				Physical characterization	
	Cooking bag	Blade tenderizer	Marinade	Low-temperature cooking	Shear force (g.sec)	Water content (%)
Chicken breast						
Control	√				10949	71.7
BT	√	√			18013	72.6
BT-M	√	√	√		14113	73.4
LT	√			√	14717	74.8
BT-LT	√	√		√	14130	73.9
Roast beef						
Control	√				35662	66.9
LT	√			√	29126	71.0
BT-LT	√	√		√	20933	68.4
M–LT	√		√	√	21754	70.0
BT-M-LT	√	√	√	√	16940	72.0
Beefsteak						
Control	NA			NA	42147	66.6
BT	NA	√		NA	43142	70.0
M	NA		√	NA	48799	66.5
BT + M	NA	√	√	NA	28277	69.2

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