COMPARISON OF LABORATORY AND HUMAN SENSORY ANALYSIS OF MEAT (BEEF) TEXTURAL PROPERTIES

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I. INTRODUCTION

A significant number of people worldwide suffer from dysphagia (difficulty in swallowing) with numbers expected to increase as populations age. Meat texture after cooking is a critically important parameter that determines consumer purchasing preferences, but it is especially important for sufferers of dysphagia. Meat textural attributes such as hardness, cohesiveness and chewiness are of particular importance in the oral processing and swallowing of meat, and can be evaluated using both objective (laboratory) and subjective (human sensory) measures. In this study, the texture of beef *semitendinosus* muscle was assessed after cooking by using both a texture profile analyzer (TPA) and a human sensory panel. The ability of panelists to determine meat textural attributes relative to analysis by the TPA was statistically analysed.

II. MATERIALS AND METHODS

Beef meat (*semitendinosus* [*ST*], day 1 *post mortem*) was purchased from a local commercial meat supplier. Right and left muscles were obtained from the same animal to limit sample variation. Each muscle was cut into similar-sized pieces (150±30g) which were individually packed and sealed in polythene pouches using a vacuum sealer. The slices were cooked by water immersion at selected temperature*time combinations (65°C*30min, 65°C*60min, 75°C*30min, 75°C*60min, 85°C*30min, 85°C*60min). After cooking samples were cooled by immersing pouches in water at 20°C for 20 min. The meat was then removed from the pouches, excess fluid removed by placing between layers of tissue paper and samples then weighed to determine % water loss. Samples were divided into two equal portions, one for instrumental analysis and the other for human sensory analysis.

For all analyses, the cooked surfaces on the meat slices were removed and then six 15mm cubes cut parallel to the longitudinal orientation of the muscle fibre. Samples (cubes) were individually analysed in the laboratory using a Stable Micro System TA.XTplus texture profile analyzer (TPA) with a 25mm dia. probe with the fibre axis of each cube perpendicular to the direction of the probe [1]. Force time deformation curves were used to calculate hardness, cohesiveness, springiness, adhesiveness and chewiness [2]. For human sensory evaluation, 8 panelists were selected aged 18-65 years from RMIT students and staff and trained in accordance with standard procedures [3,4]. Meat cubes were given to panelists in random order and each panelist asked to rate textural attributes using standard ranking scales [4]. A sixth textural attribute, juiciness, was also rated by the panel. Data were analyzed using SPSS software, using one-way analysis of variance (ANOVA) and Tukey HSD test to compare textural attribute means for the different cooking treatments. Correlation levels were determined by calculating both Pearson's correlation coefficient (r) and the coefficient of determination (R^2). Ethics approval to use voluntary human participants in these studies was obtained from the RMIT Human Research Ethics Committee (ref no: HREC 20635).

III. RESULTS AND DISCUSSION

Textural measurements for the different cooking conditions were compared. The results (Table 1) showed that hardness and chewiness determined instrumentally and by human sensory panel both increased whereas adhesiveness decreased with increased cooking conditions, and that the differences between cooking conditions were significant. This increase in hardness presumably was due to the loss of water as well as coagulation of myofibrillar proteins and constriction of collagen that happens during heating [5]. The increase in hardness and chewiness would result in a greater number of chews being needed during eating to make a bolus safe for swallowing. Springiness increased with the increased cooking conditions, but this was seen only for the instrumental measurements and was not statistically significant (Table 1).For cohesiveness neither instrumental nor human sensory measurements showed a clear pattern. The % water loss of samples increased with increasing cooking conditions, as expected, while juiciness (assessed by the sensory panel) decreased.

Table 1. Comparison of textural attributes of meat samples. P-values were calculated by one-way ANOVA comparing the data for each textural attribute for laboratory instrument (column 2) and human sensory (column 3) measurements for (n) samples (n=4 or n=8, respectively) under different cooking conditions (for details see Materials and Methods). Tukey's HSD test (data not shown) gave similar results. The P-values show that all textural attributes except springiness and cohesiveness have changed with increased cooking. Columns 4 and 5 show the calculated degree of correlation between the instrumental data including water cook loss (X-axis) and human sensory data (Y-axis) for each textural attribute (plots are not shown). Pearson's (r) and the Coefficient of Determination (R^2) were calculated.

Attribute	P-value (instrument)	P-value (human sensory)	Pearson's Coefficient (r)	Coefficient of Determination (R^2)
Hardness	0.003**	0.003**	0.953	0.909
Chewiness	0.031*	0.002**	0.853	0.727
Adhesiveness	0.014*	0.015*	0.903	0.815
Springiness	0.374	0.456	0.447	0.199
Cohesiveness	0.224	0.345	0.583	0.339
Juiciness/ cook loss	0.007**	0.005**	–0.929	0.863

A strong positive correlation existed between instrumental and human sensory values for hardness, chewiness and adhesiveness (Table 1, columns 4 and 5). However, correlation coefficient values for springiness and cohesiveness were low, presumably mainly due to variability in the human panel assessments. Negative correlation was observed between juiciness and the % water loss. Difficulties with human sensory panels being able to accurately determine meat springiness and cohesiveness have been previously reported by others [6].

IV. CONCLUSION

Meat tenderness after cooking is defined by specific textural characteristics that can be measured both instrumentally (e.g. with a TPA) and by human sensory panels. In this study, we found good correlation existed between meat hardness, chewiness and adhesiveness measured using both approaches. However, the ability of human panelists to determine meat springiness and cohesiveness – even after training – was relatively poor. Using both approaches to determine meat tenderness is (nonetheless) preferable.

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