Food Chemistry 136 (2013) 1597–1602

Contents lists available at SciVerse ScienceDirect

Food Chemistry

journal homepage: www.elsevier.com/locate/foodchem

Comparison of consumer perception and acceptability for steaks cooked to different endpoints: Validation of photographic approach

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ARTICLE INFO

Article history:
Available online 21 April 2012

Keywords:
Cooked meat
Sensory evaluation
Food photographs

ABSTRACT

Photographs have been used to enhance consumer reporting of preference of meat doneness, however, the use of photographs has not been validated for this purpose. This study used standard cooking methods to produce steaks of five different degrees of doneness (rare medium, medium well, well done and very well done) to study the consumer's perception of doneness, from both the external and internal surface of the cooked steak and also from corresponding photographs of each sample. Consumers evaluated each surface of the cooked steaks in relation to doneness for acceptability, 'just about right' and perception of doneness. Data were analysed using a split plot ANOVA and least significant test. Perception scores (for both external and internal surfaces) between different presentation methods (steak samples and corresponding photos), were not significantly different ($p > 0.05$). The result indicates that photographs can be used as a valid approach for assessing preference for meat doneness.

1. Introduction

Cooking meat results in a number of chemical reactions including protein denaturation (Warriss, 2010) and Maillard browning reactions (Friedman, 1996) which change the appearance of both the external and internal surface (King & Whyte, 2006). The temperature to which meat is cooked is critical for the destruction of pathogenic bacteria and the United States Department of Agriculture, Food Safety Inspection Service has specified temperatures that must be reached during the cooking of beef, and different time–temperature combinations that can be used to achieve this (USDA, 2011).

Degree of doneness is well correlated with heterocyclic amine formation in cooked meat (Ferguson, 2010) and therefore, corresponding photographs (of varying degrees of meat doneness) may be a useful accompanying tool in dietary surveys to assess exposures to chemical compounds such as heterocyclic amines (HCAs) (Scheppach & Scheurlen, 2003). The formation of these HCAs depends on two main factors: cooking method and degree of doneness. Since consumers have different perceptions of degree of doneness, food photographs have been included previously in some dietary questionnaires to improve the accuracy of reporting of doneness preference (Sinha, 2002). However, in a recent review, Zheng & Lee (2009) commented that use of photographs to assess doneness had not been validated.

For that reason, validation of photographs is an important first step to confirm their usefulness in eliminating between-consumer differences in doneness perception. Because heterocyclic amines are formed on the meat surface during cooking, validation of photographs of doneness using both internal and external meat surface views is necessary. Validation in this context means to compare how consumers perceive doneness between viewing cooked beef steaks and their corresponding photos. Therefore, the aim of this study was to compare perception of doneness between viewing cooked meat of varying doneness and their corresponding photographs to assess the reliability and accuracy of using food photographs as an assessment tool. The second aim was to determine whether consumers better assess doneness using either the internal or external surface. In these experiments, photographs were taken under controlled and standardised conditions and developed using standardised colour management system protocols to ensure that the appearance of the photograph colour matched that of the actual meat sample presented.

2. Materials and methods

2.1. Sample preparation

Vacuum-packed half sirloin (*Longissimus lumborum* ~4 kg) was purchased at a local wholesaler on the day of experiment. The

Abbreviations: VR, very rare; R, rare; MR, medium rare; M, medium; MW, medium well; WD, well done; VWD, very well done.

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http://dx.doi.org/10.1016/j.foodchem.2012.04.069

external connective tissue (epimysium) and any external fat of the sirloin were trimmed and it was further cut into 25 steaks (25 mm thick and approximately 110 g each). Raw steak samples were selected from each batch (5 steaks) for pH measurement before the start of cooking and it was measured in duplicate using a TPS WP-80 pH-mV-temperature metre (Aquaspex, Blackwood, Australia). All samples were stored at 4 °C prior to experimentation. Cooking protocols used followed the general procedure described by Watson, Polkinghorne, and Thompson (2008) with optimised cooking time and grill temperatures. Prior to cooking, a type K thermocouple (Omega Engineering Inc., Manchester, UK) was inserted into the middle of one steak in each batch to monitor internal temperature during subsequent cooking. Temperature data were collected at 10 s intervals. This was done using an auto data-logger (Squirrel SQ800, Grant Instrument Ltd., Cambridgeshire, UK) during cooking. Five steaks were pre-weighed and placed on a double-sided grill (S-143, Silesia, York, UK) set at 200 °C and the top side of the grill was closed 15 s later. The distance between the top and bottom sides of the grill was fixed at 18 mm to ensure uniform pressure was applied to each sample. Consecutive batches of steaks were cooked for different lengths of time to achieve different degrees of doneness: rare (3 min; 60 °C), medium (4 min; 70 °C), medium well (4.5 min; 75 °C), well done (5 min; 80 °C), and very well done (5.5 min; 85 °C). After the designated cooking time, steaks were removed from the grill immediately, and thermocouples were kept in position in steaks for an additional 1 min to record the end-point temperature. Steaks were weighed again after removing the thermocouples.

2.2. Shear force and cooking loss measurement

Cooked samples were chilled in fridge immediately after cooking and Warner–Bratzler Shear Force (WBSF) was measured within 24 h. Chilled steaks were allowed to reach ambient temperature (20 °C) and 10 cores (13 mm diameter) were drilled from each sample parallel to the muscle fibre. Cores were sheared perpendicular to the muscle fibres using a Warner–Bratzler shear attachment mounted on an Instron Universal Testing Center (Model 3366, Instron, Norwood, USA). Percentage weight loss was calculated using pre- and post-cooking weights of steaks.

2.3. Consumer panel

This study was approved by School of Biological Sciences Research Ethics Committee, Queen's University Belfast. Consumer-based sensory panels were conducted (four separate panels of $n = 10$ panellists) to evaluate the visual acceptability of steaks cooked to five different end-point temperatures. Volunteers (19 male and 21 female) who consumed beef on a regular basis (at least once a week), were recruited from the Agri-Food and Biosciences Institute (AFBI) and Queen's University Belfast. Each consumer attended two evaluation sessions separated by a two week interval. At the first session, consumers visually evaluated the steak samples; at the session 2, they evaluated the corresponding photographs of steaks they had evaluated in session 1. Sensory software Fizz (Biosystems, Couternon, France) was used to create a computer-based questionnaire which also recorded results.

2.4. Sensory evaluation

2.4.1. Session 1: Evaluation of steaks

Prior to being presented with the samples, consumers were briefed on how to use the scoring in the questionnaire. All evaluation sessions were conducted in a sensory booth equipped with D65 fluorescent lights (Osram daylight tube L18/965BIO, General Lamps Ltd., Buckinghamshire, UK). All questions were displayed on a computer screen one at a time. They were then asked to state their preference for steak doneness and to give some of their background information (e.g. age group, gender).

Each of the five steaks cooked in each batch were cut in half (creating 10 steaks portions) and allocated to serve to each of the 10 panellists. The presentation order of steaks according to doneness was randomised across the four panels using Fizz software. Panellists were served 5 steaks in total, corresponding with each degree of doneness and each half steak was placed on a paper plate with random three-digit numbers to identify the sample. Photographs of each steak were taken immediately before serving to the consumer to capture the image of the external appearance. Consumers were then presented with steaks with the internal side facing away from their view (view A; see Fig. 1) to eliminate the possible influence of viewing the internal appearance of the steak sample while evaluating external view.

For each external view (view A) of the steak sample participants were asked to rate the acceptability (1 = extremely unacceptable, 7 = extremely acceptable), degree of doneness (just about right) (1 = extremely undercooked, 4 = just right, 7 = extremely overcooked) and perception of doneness (1 = very rare, 7 = very well done) on a 7-point category scale.

After evaluating View A and completing the questionnaire, participants were then asked to cut the steak in half to evaluate the internal appearance (view B; see Fig. 1) for acceptability, just about right and perception of doneness After completing the questionnaire, the steaks were removed from the panellists and the next steak presented until each panellist had viewed all five steaks of different doneness. Photographs of the internal surface (view B) were taken after evaluations were completed.

2.4.2. Session 2: Evaluation of corresponding photographs of steaks

Two weeks later, the same group of consumer panellists were recalled to evaluate the sets of photographs (Views A and B) for all five degrees of doneness corresponding to the steaks they had evaluated in session 1. Photographs were presented in the same order (as in session 1) and panellists were asked the same question on acceptability, just about right and perception of doneness as they had done for the actual meat samples. After completing the questionnaire, consumers were shown the photographs again (coded as new samples) for two selected degrees of doneness (M and WD) to assess their consistency in scoring and evaluating samples.

2.5. Photography of steak samples

D65 fluorescent lights were chosen as the standard illuminant in this experiment. The cooked steak samples were photographed using a NIKON D70 digital SLR camera equipped with a 60 mm lens

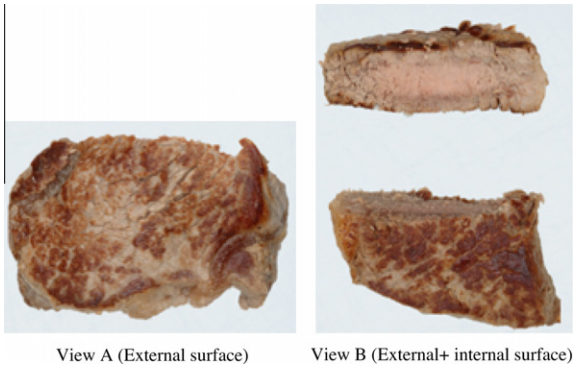

Fig. 1. External surface (view A) and external with internal surface (view B of steak samples presented in sensory evaluation sessions.