COOKING ENDPOINT TEMPERATURE AFFECTS WARNER-BRATZLER SHEAR FORCE AND COOKING LOSS OF SEAFOOD

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I. INTRODUCTION

Texture of cooked seafood influences consumer acceptability [1]. Temperature changes during cooking result in protein denaturation, whereby protein structure is altered by the formation of new intermolecular bonds [2] which can also reduce cooked seafood's water holding capacity [3]. These temperature dependent changes impact seafood texture. Denaturation of collagen is known to decrease seafood hardness [4], but the effect of denaturation of actin/myosin, and water loss, on texture is less understood. This study aims to characterise the temperature dependent protein and water holding capacity changes associated with WBSF (Warner Bratzler shear force) changes in abalone, barramundi and scallops across a range of cooking endpoint temperatures.

II. MATERIALS AND METHODS

Scallops (*Mizuhopecten yessoensis*), barramundi (*Lates calcarifer*) and abalone (*Haliotis laevigata*) were cooked to endpoint temperatures of 5, 40, 50, 60, 70 and 80 °C (n = 8 for each species at each endpoint temperature; eight different collection days) and WBSF and cook loss were measured. All samples were purchased frozen, and were defrosted overnight, then scallops – approximately 30 mm long by 20 mm wide – were cut to 10 mm thick slices, and the abalone and barramundi cut to 30 x 20 x 10 mm blocks. Samples were patted lightly with paper towel and weighed, placed in plastic pouches, randomly assigned endpoint temperatures and cooked by heating at 0.7 °C per minute in a water bath until assigned endpoint temperature was reached. Pouches were immediately cooled in 5 °C water and after one hour were lightly dried with paper towel and re-weighed; cooking loss was calculated as weight difference before and after cooking expressed as percent of initial weight. For WBSF, cooled samples were cut to 10 x 10 x 30 mm and analysed with a Lloyd texture analyser (Amatek Inc. Berwyn, Palo Alto, USA). Protein denaturation was measured using differential scanning calorimetry (DSC) with a Thermal Analysis System DSC 3 (Mettler-Toledo, Port Melbourne, Victoria, Australia). For each species, triplicate 32±5 mg of tissue was placed in a hermetically sealed aluminium pan, placed in a furnace and heated at 5 °C/min. Peak temperature (Tmax) was determined from the thermogram by interpolation of linear regions before and after the peak. The effect of temperature endpoint on WBSF and cooking loss was analysed using ANOVA in Minitab (version 19.1.1) where the fixed factor was endpoint temperature and the random model included collection day. The effect of cooking loss on WBSF was also analysed by fitting it as a covariate with temperature endpoint as the fixed effect and collection day as random.

III. RESULTS AND DISCUSSION

Figure 1a shows the DSC thermograms, and two peaks are evident for abalone whereas three peaks are evident for barramundi and scallops and these peaks have variously been attributed to the proteins myosin, actin, collagen and sarcoplasmic proteins [3, 5, 6]. Figure 1b shows there was an effect of cooking temperature on WBSF for all three species. For abalone, increasing temperature resulted in decreasing WBSF whereas for barramundi there was increasing WBSF above 40 °C, and for scallops, there was increasing WBSF above 5 °C. The differences in WBSF for the different endpoint temperatures may be explained by protein denaturation observed in the DSC. Peak 1 (Tmax = 52 °C) in abalone corresponds with a reduction in WBSF between 40 to 50 °C, likely attributed to myosin and collagen at these temperatures [3]. It is surprising that protein denaturation decreased the WBSF as Yu *et al.* [3] found an increased shear force cooking up to 70 °C for 10 minutes. They also found that cooking for longer and at higher temperatures did decrease hardness, likely due to full denaturation and partial degradation of myofibrillar proteins. Conversely, peak 1 (Tmax = 52 °C) of barramundi coincided with an increase in WBSF between 40 and 50 °C, indicating that myosin denaturation increases the toughness of barramundi; this contrasts with Llave *et al*. [7] who found no effect of myosin denaturation on tuna hardness. Peak 1 for scallops (Tmax = 40 °C, unidentified protein) coincided with an increase in WBSF between 5 and 50 °C when the denaturation of peak 1 was complete. In scallops, WBSF increased with cooking temperature, similar to Wu *et al.* [8]. Cooking loss was affected by temperature endpoint as seen in Figure 1, but was not significant when included as a covariate in the analysis of WBSF (P>0.05).

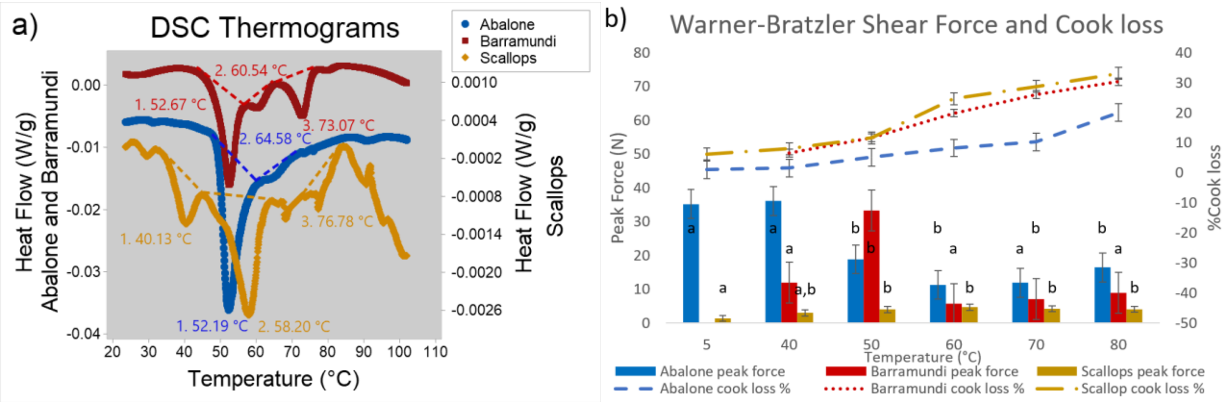

Figure 1: (a) DSC thermograms. Dotted lines are the baselines for the peaks numbered with peak temperatures (Tmax). (b) Warner-Bratzler Shear Force for each temperature, error bars are the standard error of the difference within a species. The P-values were as follows. WBSF; $p<0.05$ for all. Cook loss; $p<0.001$ for all.

IV. CONCLUSION

Cooking temperature impacts texture of seafood, and the effect is predominantly mediated by denaturation of key proteins, but not by water loss.

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