

Comparison of the single-step and double-step sous-vide treatment effect on the quality attributes of chicken breast

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Introduction

Poultry meat represent a healthy diet for many consumers as it is protein rich with high content of PUFA (polyunsaturated fatty acids). Considering these advantages, food scientists have been continuously trying to develop new poultry based ready-to-eat (RTE) meals that meet the consumer preferences and expectations. Sous-vide processing is considered as a uniform heat treatment of food in a heat-stable vacuumed pouches kept in circulation water baths at precisely controlled conditions of time and temperature. The traditional sous-vide method uses an only well controlled temperature in the range of 55-70°C (Baldwin, 2012). Selection of time and temperature parameters used during sous-vide cooking plays an important role on the meat texture changes due to the denaturation of proteins (Zielbauer et al., 2016). Proteolytic enzymes in meat break down the structure of muscle fiber which results in higher tenderness (Lawrie & Ledward, 2014). From literature, proteolytic enzymes in meat can remain active up to 50°C but with higher temperature they start to degrade and inactivate at above 65°C. The tenderness can be potentially increased by employing the meat's own proteolytic enzymes by fine tuning the sous-vide cooking process by including processing steps below 50°C. However, careful attention must be taken on this enzyme activation temperature range because it is overlapping the intensive bacterial growth temperature range this is a possible food safety risk especially in the poultry meat (Yang et al., 2020). According to FSIS (2005), safe poultry product can be produced for the immune-compromised people by a 35 min heat treatment at 60°C. Based on our knowledge, no studies on literature can be found on investigating the effect of the double-step sous-vide cooking on quality attributes of the chicken breast. Therefore, in our study we compared the effect of the traditional single-step and the double-step sous-vide treatment on the quality attributes of the sous-vide treated chicken breast.

Materials and Methods

The raw material used for the study was fresh chicken breasts (*musculus pectoralis major*) boneless and free of fat and connective tissues. Chicken breast meat was cut into uniform pieces (129 ± 4 g weight, 2.0 ± 0.2 cm thickness). Chicken breast pieces were randomly selected to form 8 groups consisting of single-step sous-vide treatments (T1, T5) and double-step sous-vide treatment (T2-T4, T6-T8). The first step sous-vide temperature was 45°C and the second step temperature was 60°C (Table 1). Each treatment was repeated three times.

Table 1. Processing steps applied in the study.

Treatments	Time at the first step temperature of 45°C (min)	Time at the end step temperature of 60 °C (min)
T1	0	120
T2	40	80
T3	60	60
T4	80	40
T5	0	180
T6	60	120
T7	90	90
T8	120	60

Prior to vacuum packaging, a data logger equipped with a needle type thermocouple was placed at the thickest point of one of the samples to monitor the internal temperature during cooking. Sous-vide cooking process was carried out in the thermostatic water bath. After that the pouches were cooled back in ice water (1 °C) and kept refrigerated (2°C) prior to the analysis in the next day. The measured parameters were weight loss, pH, moisture content, Lab color attributes and texture.

Results and discussion

As expected, all the double-step sous-vide treated chicken breasts obtained higher moisture content compared to the single-step sous-vide treated chicken breast (T1 and T5) (Figure 1). This can be explained by the fact that lower cooking temperatures result in higher water content in meat because of less release of the muscle fibers sarcoplasmic fluid. The 2h and 3h double-step sous-vide treatments gave lower weight loss compared to the 2h respectively 3h single-step sous-vide treatments at 60°C (T1 and T5) (Figure 1). Similar results were observed in the study of Ismail et al., (2019) where the double-step sous-vide cooking treatment reduced the weight loss and improved the water binding capacity of both goat and beef meat. All the double-step sous-vide treatments gave significantly higher cooking yield compared to the single-step sous-vide treatments ($p \leq 0.05$).

Quality attributes of sous-vide treated chicken breast are shown in Table 2. Chicken breast processed with single and double-step sous-vide treatments had higher pH in relation to the raw material (pH=5.83). Double-step sous-vide treatments tended to decrease the shear force values (N) for chicken breast (Table 2). The low shear force values for the double-step sous-vide treatments could be explained by desmin degradation in myofibrillar muscle component that is known to be an indicator of the extent of meat tenderization during proteolysis (Zhang et al., 2006). Davey & Gilbert, (1976) have found an exponential relation between the proteolytic activity and temperatures up to 40°C.

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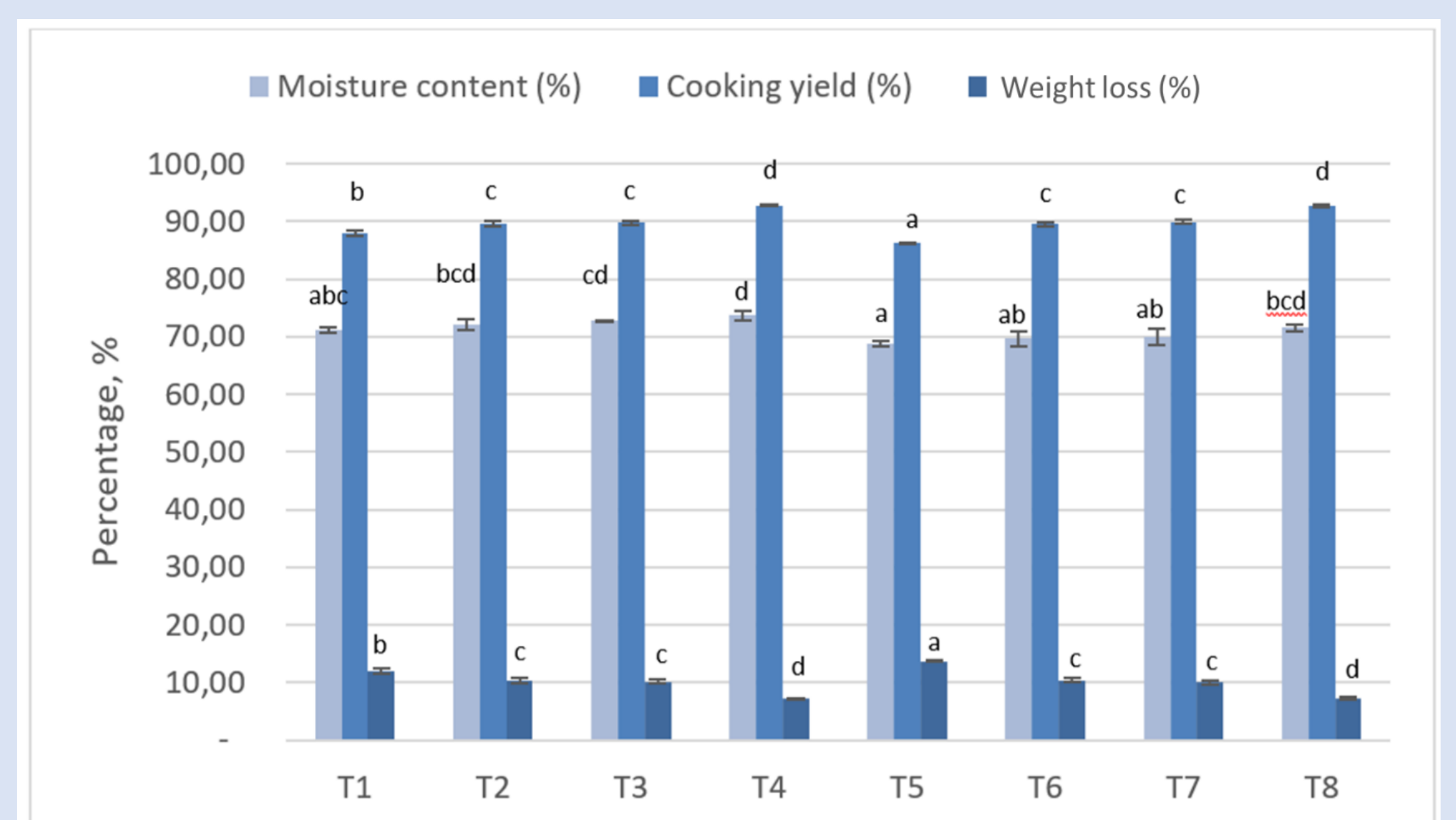


Figure 1. Moisture content, cooking yield and weight loss of the sous-vide chicken breasts cooked at different time-temperature combinations. Data with different letters mean the significant difference ($p \leq 0.05$).

Redness was significantly higher in all of the 2h and 3h double-step sous-vide treatments compared to the 2h and 3h single-step sous-vide treatment (T1 and T5) ($p \leq 0.05$). These results shows that the redness was preserved in the 2h and 3h double-step sous-vide treated chicken breast. Double-step sous-vide treated chicken breasts showed higher yellowness than those cooked using a single-step sous-vide method (Table 3).

Table 2. Characterisation of chicken breast as sous-vide treated samples

Time	2h				3h			
	T1	T2	T3	T4	T5	T6	T7	T8
Shear force (N)	25.85 ^a	19.89 ^{bc}	19.02 ^{cde}	19.05 ^{cd}	24.37 ^{ab}	16.52 ^{cde}	14.03 ^{de}	13.61 ^e
L*	79.99 ^a	78.55 ^{bc}	79.04 ^b	76.78 ^d	80.38 ^a	80.06 ^a	78.83 ^{bc}	78.07 ^c
a*	1.62 ^{ab}	2.34 ^{cd}	2.32 ^{cd}	2.72 ^d	1.34 ^a	2.01 ^{bc}	2.53 ^d	2.0 ^{bc}
b*	9.55 ^{ab}	9.76 ^{bc}	11.62 ^e	9.96 ^{cd}	9.19 ^a	9.23 ^a	10.1 ^{cd}	10.27 ^d
pH	6.00 ^a	6.03 ^{ab}	6.03 ^{ab}	6.00 ^a	6.13 ^c	6.08 ^{bc}	6.04 ^{ab}	6.01 ^{ab}

Data with different letters mean the significant difference ($p \leq 0.05$).

Conclusions

Double-step sous-vide treatments provided an attractive cooking method to produce high quality chicken breast as it reduced shear force values while obtained higher moisture content, redness and lower weight loss of chicken breast as compared to the traditional single-step sous-vide treatment. According to FSIS, (2005) it takes 35 min at 60°C of cooking poultry to be made safe even for the immune-compromised people. The selected time and temperature combination treatments seems to meet the food safety criteria, however it would be useful to carry out challenge tests of specific pathogens to assess the effectiveness of the treatment combination on microbiological quality.

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