Effects of whey protein and its hydrolysate on the qualities of cured sausage

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I. INTRODUCTION

Population growth and fluctuating crop yields due to climate change have worsened food problems such as poor-quality food and food shortages, and malnutrition and hunger become a global problem. In addition, the growing health consciousness has led to an increased demand for functional foods. Therefore, it is essential to develop meat products with added health and nutritional value. Whey is a byproduct of cheese production and is generated after casein is coagulated in the cheese-making process, which is rich in protein and has a high nutritional value. Whey protein hydrolysates (WPH), produced by enzymatic degradation of whey proteins (WP), have shown utility in food processing. It has also been reported that WPH contains bioactive peptides [1]. This study focused on WP and WPH, and aimed to assess their impact on sausage quality.

II. MATERIALS AND METHODS

Commercially obtained WP concentrate (Daiichirakuto EM-20; Daiichi Kasei Co., Ltd., Kyoto, Japan) and WPH (WPH; Daiichi Kasei Co., Ltd.) were used in all the performed tests. To prepare the WP and WPH ethanol (EtOH) extracts, the WP and WPH were suspended in 70% EtOH overnight at 4 °C. The suspension was centrifuged, filtered, and dried using a rotary evaporator. The dried samples were resuspended in distilled water and lyophilized to prepare the extracts. Fe^{3+} reduction was measured using a previously described method [2]. The oxidation-reduction potential (ORP) values were measured using an ORP meter (Kasahara Chemical Instruments Corp.). For the NO_2^- reducing activity, the residual NO_2^- level was determined according to a previously reported method [3], and the decrease ratio from the initial sodium nitrite concentration was determined as follows: decreasing ratio (%) = ((Ac – As) / Ac) × 100. Ac and As are the absorbance of the control and sample, respectively.

To prepare the tested sausage model, 2% NaCl, 30 ppm $NaNO_2$, and WP or WPH were added to ground pork and mixed thoroughly on ice using a mortar. After mixing, the samples were packed in sanitary plastic bags and heated at 75 °C for 20 min in a water bath (TAITEC, Koshigaya, Japan). The color of the sausage model was evaluated using a spectrophotometric colorimeter (Konica Minolta Sensing, Inc., Tokyo, Japan). The measurement was carried out in reflectance. Also, the observer angle and the light source were used 10° and D65 light, respectively. The sausage model was heated to 78°C in a water bath, and the decanted liquid and cooking loss were calculated as the weight lost during heating as a percentage of the initial weight: [100 × (initial weight − final weight) / initial weight]. A blind sensory test was also conducted to evaluate the palatability of the tested sausage model among the participants.

III. RESULTS AND DISCUSSION

As shown in Table 1, the Fe^{3+} reducing activity of the WPH EtOH extract was significantly higher than that of the WP EtOH extract at 25 and 50 mg/mL ($p < 0.05$). In addition, all ORP values of the WPH EtOH extract were significantly lower than those of the WP EtOH extract at the same contents ($p < 0.05$), and the NO_2^- decreasing ratio of the WPH EtOH extract at all levels was significantly higher than that of the WP EtOH extract ($p < 0.05$). Thus, the WP and WPH EtOH extracts exhibited

antioxidant and reducing activities [4]. As shown in Figure 1, the *a** value of 5.0% WPH EtOH extract supplemented sausage was significantly higher than that of 5.0% WP EtOH extract supplemented and control sausage ($p < 0.05$). The *L** and *b** values of 5.0% WPH EtOH extract supplemented sausage tended to be lower than those of 5.0% WP EtOH extract supplemented sausage. Additionally, the water cooking loss of 5.0 % WPH EtOH supplemented sausage was significantly suppressed compared to that of the 5.0% WP EtOH supplemented and control sausages ($p < 0.05$). Moreover, the WPH supplemented sausages demonstrated a high score in the flavor category of the palatability test. Therefore, WPH is expected to have improved the quality of cooked sausages.

Table 1 – Antioxidative and reducing activities of WP and WPH EtOH extracts.

Concentration (mg/mL)		Fe^{3+} reduction (umol/L: Trolox equivalent value)	ORP value (mV)	NO_2^- decreasing ratio (%)
WP EtOH extract	10	11.24 ± 8.74	228.0 ± 15.7	29.86 ± 5.80
	25	17.56 ± 12.32	210.0 ± 5.6	27.77 ± 7.08
	50	31.25 ± 25.35	206.5 ± 13.9	22.62 ± 6.29
WPH EtOH extract	10	27.79 ± 11.98	181.3 ± 5.7 *	42.08 ± 6.89 *
	25	63.05 ± 11.64 *	168.5 ± 9.3 *	40.82 ± 2.03 *
	50	104.87 ± 12.32 *	160.0 ± 15.9 *	33.95 ± 5.00 *

*: p<0.05 vs the value of WP-EtOH at the same concentration

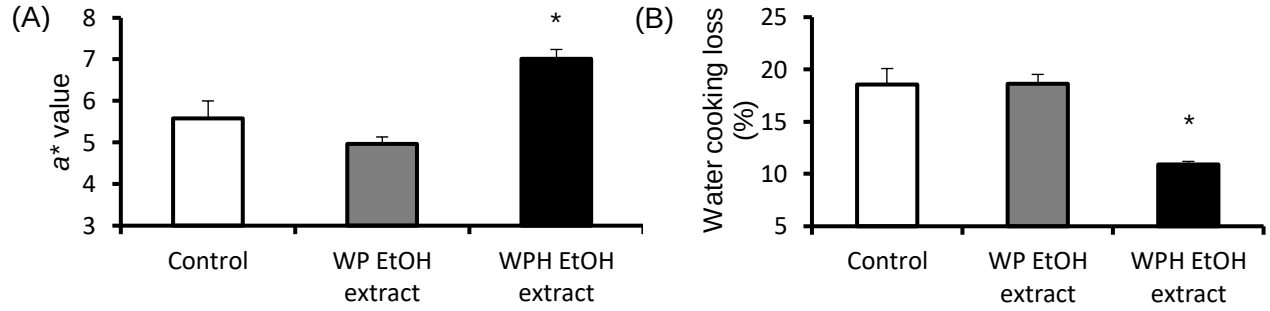

Figure 1. Redness and water holding capacity of sausages added WPH EtOH extracts.

(A) and (B) show *a** value and water cooking loss of sausage models, respectively. *: p<0.05 vs the control and WP

IV. CONCLUSION

In conclusion, this study demonstrated that WPH extracts not only showed antioxidative and/or reducing activities but also improved the quality of cooked sausages. WPH is known to have high potential for nutritional supplementation. In meat processing, WPH contributes not only to nutritional supplementation but also to the addition of bioactivities (such as antioxidant and reducing actions) and improves the quality of meat products.

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REFERENCES

1. Vavrusova, M. et al. (2015). Characterisation of a whey protein hydrolysate as antioxidant. *International Dairy Journal*, 47: 86-93.
2. Ferreira, IC. et al. (2007). Free-radical scavenging capacity and reducing power of wild edible mushrooms from northeast Portugal: Individual cap and stipe activity. *Food Chemistry*, 100(4), 1511-1516.
3. Mirna, A. (1972). Verfahren zur gleichzeitigen Bestimmung des Pökelfarbstoffes sowie von Nitrit und Nitrat in Fleischerzeugnissen. *Fleischwirtschaft*, 52, 1337–1338.
4. Takeda, S. et al. (2023). Reducing effects of whey protein hydrolysate on coloration of cured sausages. *Foods*, 13(1), 13.