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UTILIZATION OF WAX-BASED OLEOGELS AS A SOLID FAT REPLACER IN PLANT-BASED MEAT ANALOGUES

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I. INTRODUCTION

Globally, the consumption of plant-based meat analogue is increasing due to environmental sustainability, ethical considerations, and health benefits. Solid fats high in saturated fatty acids have been used for improving the texture and stability of meat analogues. However, solid fats negatively impact human health due to their high saturated fat content, prompting the food industry to seek alternatives. Recently, oleogelation technology, which can transform liquid oils into solid fats without chemical modification [1], has gained scientific attention. In this study, oleogels were created by mixing natural waxes as gelators with canola oil, and then applied to meat analogues as solid fat replacers.

II. MATERIALS AND METHODS

Oleogels were prepared by blending three different waxes (candelilla wax, carnauba wax, and beeswax) with canola oil at 10% (w/w). The solid fat content of the oleogels was determined using an Oxford MQC+ nuclear magnetic resonance (NMR) (Oxon, UK) over a temperature range of 10°C to 90°C. The hardness of oleogels was measured using a texture analyzer (TAXT plus, Stable Micro System Ltd., Surrey, UK) equipped with a rod probe. The formulation of meat analogues consisted of 17.63% texturized soy protein (TaekyungNongsan, Seoul, Korea), 16.01% coconut oil (TaekyungNongsan, Seoul, Korea), 1.92% methycellulose (Lotte Fine Chemical, Seoul, Korea), and 59.27% water. The control meat analogue was prepared with coconut oil and coconut oil was completely replaced with each oleogel sample. The cooking loss and hardness of the meat analogues after cooking (150°C) were measured.

III. RESULTS AND DISCUSSION

The hardness of canola oil oleogels prepared with three different waxes was measured at room temperature using a puncture test and compared (Figure 1(a)). The oleogel made with candelilla wax exhibited the hardest texture, followed by carnauba wax and beeswax. This result demonstrates a similar trend to the findings reported by Lim et al. [2]. As shown in Figure 1(b), oleogels containing carnauba wax maintained a stable solid fat content up to 50°C, after which a gradual decrease in solid fat content was observed at higher temperatures. In the case of candelilla wax oleogels, a reduction in solid fat content began about at 30°C, and the oleogel completely melted at 70°C. The beeswax oleogel samples exhibited the lowest melting point, with no solid fat content detected beyond 50°C.

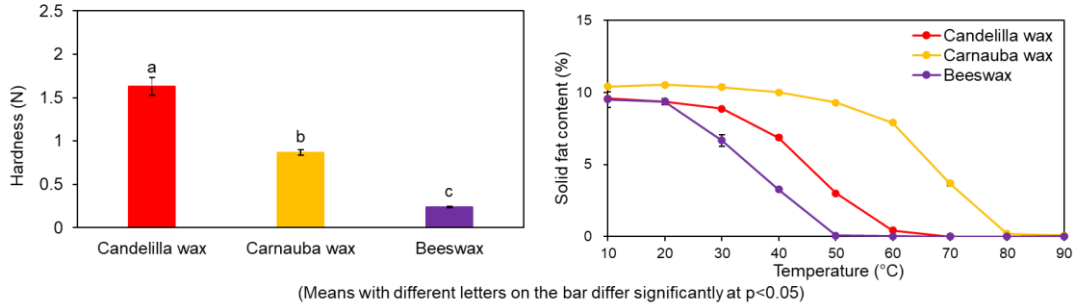


Figure 1. (a) Hardness and (b) solid fat content of oleogels

The cooking loss of meat analogues in which coconut oil was replaced with three different oleogels, was analyzed (Figure 3(a)). Overall, meat analogues containing oleogels exhibited lower cooking loss than the control prepared with coconut oil. In particular, the sample prepared with carnauba wax oleogel showed a cooking loss of 12.0%, which was approximately 35% lower than that of the sample made with coconut oil. This result showing that carnauba wax oleogel had the lowest cooking loss could be attributed to its high viscosity.

Figure 3(b) shows the texture properties of meat analogues formulated with coconut oil and oleogels. The sample prepared with candelilla wax oleogel exhibited the highest hardness, whereas the one made with beeswax oleogel showed the lowest hardness. These results seemed to be correlated with the rheological properties of oleogels and cooking loss. Specifically, the beeswax oleogel, which had the lowest viscosity, exhibited the lowest hardness, whereas the candelilla wax oleogel, with higher viscosity, showed greater hardness. Despite its high viscosity, the carnauba wax oleogel exhibited lower hardness than the candelilla wax oleogel, which may be attributed to its low cooking loss, allowing it to retain a higher amount of lipid after cooking.

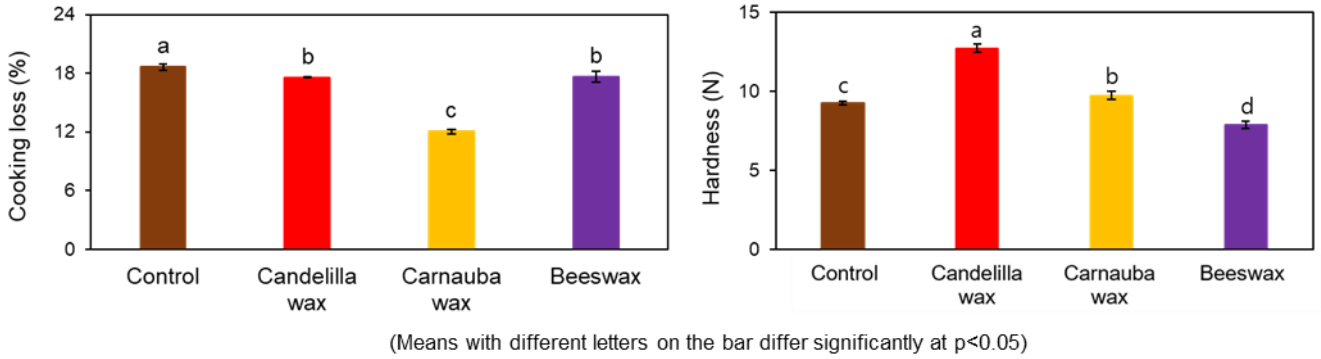


Figure 2. (a) Cooking loss and (b) texture of plant-based meat analogues prepared with oleogels

The fatty acid compositions of meat analogues formulated with coconut oil and oleogels were investigated (Table 1). In the sample made with coconut oil, lauric acid, myristic acid, and palmitic acid were the predominant fatty acids. On the other hand, oleic acid, linoleic acid, and linolenic acid were the major fatty acids in the meat analogues formulated with oleogels. Thus, the meat analogues with oleogels exhibited a fatty acid profile similar to that of canola oil [3]. As a result, the meat analogues made with coconut oil contained the highest proportion of saturated fatty acids (90%), whereas the oleogel samples had significantly lower levels (7–9%) and a higher proportion of unsaturated fatty acids (90–92%).

Table 1. Fatty acid compositions of vegetable oils and plant-based meat analogues prepared with oleogels.

	Canola oil	Coconut oil	Meat analogues			
			Control	Candelilla wax	Carnauba wax	Beeswax
Saturated (%)	7.75±0.03	90.51±0.10	90.40±0.05	7.14±0.02	8.00±0.01	9.91±0.02
Unsaturated (%)	92.25±0.03	9.49±0.10	9.60±0.05	92.86±0.02	92.00±0.01	90.09±0.02
SFA / UFA	0.08±0.00	9.53±0.11	9.41±0.05	0.08±0.00	0.09±0.00	0.11±0.00

IV. CONCLUSION

In this study, the effect of solid fat replacement with oleogels on the quality attributes of plant-based meat analogues was evaluated. When oleogel was used instead of coconut oil, there was no noticeable difference in the appearance of the meat analogue, and it exhibited texture characteristics comparable to those of the meat analogue made with coconut oil. Furthermore, it was possible to produce a nutritionally superior meat analogue with reduced saturated fat. These findings are expected to provide valuable insights for the development of low-saturated fat meat analogues in the food and meat industry.

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