

# EFFECTS OF PACKAGING METHODS AND FROZEN TEMPERATURE ON THE COLOR OF FROZEN BEEF ROLLS

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## I. OBJECTIVES

Beef rolls are popular among Chinese consumers, which makes them a widely used ingredient in hot pot meals. Beef rolls are usually stored and transported in a frozen state, during which the color deteriorates quickly due to freezing. Therefore, a number of storage methods and package methods for frozen beef rolls aiming to extend color shelf life were investigated.

## II. MATERIALS AND METHODS

Samples were obtained from the *Longissimus lumborum* muscle of 6 Chinese Luxi yellow cattle. The *Longissimus lumborum* were removed from carcasses at 48 h postmortem, and then frozen and cut into thin slices of 0.1 cm and rolled into solid beef rolls with a diameter of about 2 cm. The slices were assigned randomly to 10 package × temperature groups (50% O<sub>2</sub>: 50% O<sub>2</sub> + 30% CO<sub>2</sub> + 20% N<sub>2</sub>; 60% O<sub>2</sub>: 60% O<sub>2</sub> + 40% N<sub>2</sub>; 80% O<sub>2</sub>: 80% O<sub>2</sub> + 20% CO<sub>2</sub>; CO: 0.4% CO + 30% CO<sub>2</sub> + 69.6% N<sub>2</sub> and overwrap packaging, stored at -12°C or -18°C). The surface color of beef rolls was determined by using an X-Rite spectrophotometer (Model SP62, 4 mm diameter aperture, Illuminant D<sub>65</sub>, 10° observer, X-Rite, USA). The first measurement was carried out after blooming for 30 min at day 0, and the other measurements were taken immediately in frozen state after opening packages at days 30, 90, 120, and 180.

Table 1.

Effects of packaging methods on a\* values of beef rolls at different temperatures during storage

### Packaging methods

Storage temperature (°C)	Storage times (d)	50%O <sub>2</sub>	60%O <sub>2</sub>	80%O <sub>2</sub>	CO	OP
-12	0	22.27±0.38 <sup>akx</sup>	22.27±0.38 <sup>akx</sup>	22.27±0.38 <sup>akx</sup>	22.27±0.38 <sup>akx</sup>	22.27±0.38 <sup>akx</sup>
	30	19.89±1.02 <sup>akx</sup>	20.05±0.74 <sup>aklx</sup>	15.67±0.98 <sup>bly</sup>	17.81±1.53 <sup>ablx</sup>	18.73±1.38 <sup>ablx</sup>
	90	15.82±1.94 <sup>bclx</sup>	17.98±1.52 <sup>ablmx</sup>	9.96±1.42 <sup>dmy</sup>	20.88±2.60 <sup>aklx</sup>	14.67±1.84 <sup>cmx</sup>
	120	11.81±2.04 <sup>bcmxy</sup>	14.84±1.44 <sup>bmxx</sup>	9.07±1.97 <sup>cmy</sup>	23.05±2.20 <sup>akx</sup>	11.28±1.40 <sup>cny</sup>
	180	11.14±2.07 <sup>cmy</sup>	15.05±1.86 <sup>bmxx</sup>	10.87±2.16 <sup>cmy</sup>	20.39±2.39 <sup>aklx</sup>	12.49±1.76 <sup>bcmnx</sup>
-18	0	22.27±0.38 <sup>akx</sup>	22.27±0.38 <sup>akx</sup>	22.27±0.38 <sup>akx</sup>	22.27±0.38 <sup>akx</sup>	22.27±0.38 <sup>akx</sup>
	30	20.29±0.99 <sup>aklx</sup>	21.36±0.74 <sup>akx</sup>	21.18±0.96 <sup>aklx</sup>	16.83±1.53 <sup>blx</sup>	20.15±1.76 <sup>aklx</sup>
	90	18.33±1.10 <sup>almxx</sup>	19.39±0.86 <sup>aklx</sup>	18.11±0.84 <sup>almxx</sup>	17.64±2.29 <sup>alx</sup>	16.70±0.90 <sup>almxx</sup>
	120	15.39±1.32 <sup>amxx</sup>	16.90±0.96 <sup>alx</sup>	15.55±1.76 <sup>amxx</sup>	17.04±1.57 <sup>aly</sup>	15.83±1.49 <sup>amxx</sup>
	180	15.75±0.43 <sup>amxx</sup>	17.19±0.61 <sup>alx</sup>	16.90±0.49 <sup>amxx</sup>	18.01±1.23 <sup>alx</sup>	15.50±0.87 <sup>amxx</sup>

a–d indicate significant differences between different packaging methods at the same temperature and storage time,  $P < 0.05$ ;

k–n indicate significant differences between different storage times at the same temperature and packaging method,  $P < 0.05$ ;

x–y indicate significant differences between different storage temperatures at the same storage time and packaging method,  $P < 0.05$ .

### III. RESULTS

Combined with the results in Table 1 and the consideration of economic factors, the following conclusions are drawn. When stored at  $-12^{\circ}\text{C}$  and the storage period is within 30 d, it is recommended to use overwrap packaging, and when the storage period needs to reach 30–90 d, 60%  $\text{O}_2$  modified atmosphere packaging (MAP) is recommended, for CO MAP is forbidden in China. When stored at  $-18^{\circ}\text{C}$  and the storage period is within 90 d, overwrap packaging is recommended, and when the storage period needs to reach 90–180 d, 60%  $\text{O}_2$  MAP is recommended.

### IV. CONCLUSION

This study established a number of storage methods suitable for different conditions of frozen beef rolls in terms of color stability.

Keywords: color, frozen beef rolls, modified atmosphere packaging, shelf life