

COLOR STABILITY OF RETAIL-READY BEEF DURING PROLONGED STORAGE. III. PACKAGING INFLUENCES

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ABSTRACT

Steaks from 3 different muscles were either vacuum or CO₂ packed and stored for up to 24 weeks at 3 different storage temperatures. Following storage they were displayed for up to 30 h. Measurements of pH, sensory muscle color and surface discoloration, CIE solar co-ordinates, and the oxidative states of myoglobin were taken prior to storage, during display (0, 1, 2, 4, 6, 24, 30 h), and/or immediately following display. pH declined during storage in both package types. Color became progressively darker during storage, but was not related to duration of storage. Color was also dependent upon package type during storage. Lightness (L* values) were not related to duration of storage or display, but controlled atmosphere CO₂ (CAP) samples were generally lighter in color than vacuum (V) packaged samples. Package type generally exerted little influence on deoxymyoglobin (DOMB) content, but V samples generally contained more DOMB, than CAP samples, prior to display. Although package type exerted little influence on a* values, V samples generally contained more oxymyoglobin (OMB) than CAP samples. Redness of muscle color (a* values) and OMB were both lost progressively during storage and display, irrespective of package type. Yellowness (b* values) was not influenced by package type, but yellowness was progressively lost in both package types during storage. However, b* values were not related to duration of display. Although type of packaging exerted little influence on surface discoloration, CAP samples generally contained more metmyoglobin (MMB) than V samples during display. Both MMB content, and surface discoloration increased progressively during storage and display, irrespective of package type.

INTRODUCTION

Although the effects of packaging (vacuum vs controlled atmosphere (CAP) on the microbiological and keeping qualities of meat have been thoroughly researched on both primal and retail-ready cuts, very little research has focused on the effects of packaging on the color stability of retail-ready beef cuts. Consequently, the present study was designed to provide badly needed information by characterizing and documenting the effects of packaging on the color stability of retail-ready beef cuts.

EXPERIMENTAL

Sample acquisition, preparation, storage, display, and evaluation were as previously described (Jeremiah *et al.*, 1995). Data were analyzed as previously described, except in this instance storage temperature, storage time, and display time and all two-way and three-way interactions were considered.

RESULTS

Muscle pH was negatively related to duration of storage irrespective of package type, both prior to display and after 30 h of display ($P < 0.05$, $R^2 = 0.50$ to 0.83). Although a few significant ($P < 0.05$) differences in pH were observed between package types, they were not consistent. Consequently, these results clearly demonstrate pH declined during storage, irrespective of package type.

Sensory color scores were not related to the duration of storage in either package type ($P > 0.05$), but were positively related to duration of display in samples stored in CAP for 6, 12, and 15 weeks ($P < 0.05$, $R^2 = 0.64$ to 0.96) and in samples stored under vacuum (V) for 12 and 15 weeks ($P < 0.05$, $R^2 = 0.52$ to 0.67 , respectively). In unstored samples, samples to be stored in CAP generally received higher muscle color scores than samples to be stored in V ($P < 0.05$). However, V samples generally received higher muscle color scores after 12 and 15 weeks of storage, but CAP samples generally received higher color scores after 18 or more weeks of storage, indicating muscle color is package dependent during storage.

CIE L* values were not related to duration of display in either package type ($P > 0.05$) and were positively related to duration of storage only in V samples prior to display ($P < 0.05$, $R^2 = 0.40$). When statistically significant ($P < 0.05$) differences in L* values were observed, CAP samples were generally lighter and received higher L* values than V samples. Consequently, these findings demonstrate duration of storage and display does not exert a significant influence on muscle color lightness, but CAP samples were generally lighter than V samples.

CIE a* values were negatively related to duration of display in samples stored for at least 9 weeks in CAP ($P < 0.05$, $R^2 = 0.49$ to 0.85) and V ($P < 0.05$, $R^2 = 0.56$ to 0.67). They were also negatively related to duration of storage in CAP samples displayed for at least 2 h ($P < 0.05$, $R^2 = 0.59$ to 0.86) and V samples displayed for at least 1 h ($P < 0.05$, $R^2 = 0.58$ to 0.88). Few statistically significant ($P < 0.05$) differences in a* values were detected between package types. However, when they were observed V samples generally had higher a*

values and were redder than CAP samples. These results indicate redness is progressively lost during storage and display, irrespective of package type. They also indicate package type exerts little influence on a^* values or the redness of muscle color.

CIE b^* values were not related to duration of display in either package type ($P>0.05$), but were negatively related to duration of storage in CAP samples displayed for 4, 24, and 30 h ($P<0.05$, $R^2=0.53$ to 0.71) and V samples displayed for 2 and 24 h ($P<0.01$, $R^2=0.67$ to 0.85). Few differences ($P<0.05$) in b^* values were observed, and when observed they were not consistent. Consequently, these findings indicate b^* values and the yellowness of muscle color is not influenced by package type. They also indicate yellowness of muscle color is lost in both package typed during storage but not during display.

Percent deoxymyoglobin (DOMB) was not related to duration of display ($P>0.05$), and was negatively related to duration of storage only in V samples, prior to display ($P<0.05$, $R^2=0.55$). Differences in DOMB content between package types were observed primarily prior to display, when samples generally had a higher DOMB content than CAP samples. These results demonstrate package type generally exerted little influence on DOMB content, but V samples generally contained more DOMB than CAP samples prior to display.

Percent oxymyoglobin (OMB) was negatively related to duration of storage in CAP samples displayed for at least 4 h ($P<0.01$, $R^2=0.62$ to 0.96) and V samples displayed for at least 2 h ($P<0.05$, $R^2=0.42$ to 0.94). OMB content was also negatively related to duration of display in CAP samples stored for at least 9 weeks ($P<0.05$, $R^2=0.58$ to 0.69) and V samples stored for at least 15 weeks ($P<0.05$, $R^2=0.61$ to 0.88). However, a positive relationship was observed between OMB content and duration of display in unstored CAP samples ($P<0.01$, $R^2=0.71$). Only a few statistically significant differences ($P<0.05$) in OMB content were detected between package types, but when detected during display, V samples contained more OMB and were redder in color than CAP samples. Therefore, OMB is clearly lost during both storage and display, irrespective of package type and V samples contained more OMB and had redder muscle color during display than CAP samples.

Surface discoloration scores were positively related to duration of storage in all V samples ($P<0.05$, $R^2=0.56$ to 0.96) and CAP samples displayed for 1 h or more ($P<0.05$, $R^2=0.42$ to 0.92). They were also positively related to duration of display in all CAP ($P<0.05$, $R^2=0.58$ to 0.94) and V ($P<0.05$, $R^2=0.52$ to 0.76) samples. Only a few statistically significant differences ($P<0.05$) in surface discoloration scores were detected between package types and these differences were not consistent. Consequently, type of packaging exerted little influence on surface discoloration, but both storage and display were detrimental and increased surface discoloration, irrespective of package type.

Percent metmyoglobin (MMB) was positively related to duration of storage in CAP samples displayed for at least 4 h ($P<0.01$, $R^2=0.66$ to 0.92) and V samples displayed for at least 1 h ($P<0.01$, $R^2=0.69$ to 0.96). MMB content was also positively related to duration of display in CAP samples stored for 3 and 9 to 24 weeks ($P<0.05$, $R^2=0.52$ to 0.72) and V samples stored for at least 3 weeks ($P<0.05$, $R^2=0.56$ to 0.77). Only a few statistically significant differences ($P<0.05$) in MMB content were observed between package types, but when observed, CAP samples contained more MMB than V samples. These findings clearly indicate MMB content increases progressively during storage and display in both package types and CAP samples generally contain more MMB than V samples during display.

CONCLUSIONS

Package type generally exerted only a minor influence on color stability. However, CAP samples were generally lighter in color but contained more MMB than V samples, while V samples generally contained more DOMB and OMB than CAP samples. Storage and display were detrimental to muscle color stability irrespective of package type, and produced a loss of redness and OMB and an increase in MMB and surface discoloration.

REFERENCES

- Jeremiah, L.E., L.L. Gibson, and S. Nesom-Fleet 1995. Color stability of retail-ready beef during prolonged storage. I. Muscle influences. Proc. 41st Ann. ICoMST (in press).