NONDESTRUCTIVE SEGREGATION OF COLOR-LABILE AND COLOR-STABLE BISON MUSCLES USING NEAR-INFRARED SPECTROSCOPY

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I. OBJECTIVES

The objective of the study was to investigate the potential of visible near-infrared (Vis-NIR) and short wave near-infrared (SWIR) spectroscopy for the segregation of bison muscles *longissimus lumborum* (color-stable) and *psoas major* (color-labile) based on muscle type and storage period.

II. MATERIALS AND METHODS

Ten *longissimus lumborum* (striploins) and 10 *psoas major* (tenderloins) muscles from A1 grade bison carcasses were collected within 48 h postmortem. Each muscle portion was subsampled for the determination of pH, malondialdehyde, 4-hydroxy-2-nonenal, and protein carbonyl contents, prior to which hyperspectral images (HSI) in the Vis-NIR and SWIR regions were acquired for 2 × 2 cm steaks. The remaining muscle samples were divided into 2 parts and stored at 2°C for an aging period of 7 and 14 d. At the end of each aging period, 2.5-cm-thick steaks were obtained, and HSI were acquired followed by the determination of instrumental (*L**, *a**, and *b**) color, sensory color (color and discoloration score), purge loss, pH, malondialdehyde, 4-hydroxy-2-nonenal, and protein carbonyl contents. Steaks were further used for HSI acquisition after the retail display period of 5 d, followed by determination of the aforementioned parameters. Principal component analysis was used as an unsupervised classification approach for the segregation of bison muscles based on muscle type and storage period.

III. RESULTS

Prior to the application of the principal component analysis, the spectral data in the Vis-NIR and SWIR ranges were mean-centered. In case of the Vis-NIR range, principal component 1 (PC1) explained 64.98% variance in the data and depicted groupings based on the muscle type. The loading plots portrayed a major peak starting from 580 nm to 650 nm, which represents the red region of the Vis-NIR range. Hence, this wavelength region was significant for the discrimination of muscles based on *a** values. On the other hand, PC2 (27.50%) provided a clear discrimination between fresh and aged samples (considered as one class) against samples belonging to retail day 5 with the loading plots portraying major peaks around 650 nm to 700 nm. The segregation based on the muscle type in the SWIR region was better portrayed by PC3, which explained 7.46% of variance in the data with significant loading peaks at 1,100 nm to 1,300 nm. This region is related to the water and fat absorption bands, therefore the muscle type discrimination can be attributed to these factors. Moreover, PC1 (68.88%) effectively discriminated the fresh and aged (considered as one class) against the retail display samples with major loading peaks at 1,100 nm, 1,200 nm, and 1,400 nm, which is also a water

absorption band. Therefore, the moderate discrimination based on the muscle type and storage period was acquired with effective contribution from the red region in the Vis-NIR range. In case of the SWIR range, water and fat absorption bands were the major contributors towards achieving good discrimination based on the aforementioned categories.

IV. CONCLUSION

The Vis-NIR range discriminated the bison muscles based on storage time effectively compared to the SWIR range. On the other hand, the SWIR range served better for the segregation of the 2 muscle types. These results obtained from unsupervised classification are encouraging for further processing of the spectral data using supervised classification algorithms.

Keywords: bison, color stability, principal component analysis, short wave near-infrared spectroscopy, visible near-infrared spectroscopy