Total volatile basic nitrogen (TVB-N) and its association to quality and spoilage parameters for beef

Benjamin Holman[1], Alaa El-Din Bekhit[2], David Hopkins[1]

[1] Centre for Red Meat and Sheep Development, NSW Department of Primary Industries, Cowra
[2] Department of Food Science, University of Otago, Dunedin

Introduction: Total volatile basic nitrogen (TVB-N) is often used to quantify the freshness of meat, as it is generated from the degradation of proteins and amines, by endogenous enzyme and microbial actions – these being agents of spoilage. A recent review found the link between TVB-N and other biomarkers of quality and freshness were ill-defined or unavailable for red meats, including beef (Bekhit et al. 2021). With guidelines available that define acceptable TVB-N concentrations for fish and pork, it is imperative that a TVB-N standard for beef is developed. To support this requisite, TVB-N was compared with other quality and spoilage biomarkers in aged beef.

Materials and Methods: Beef longissimus lumborum muscles (LL, n=24) were selected from individual carcasses. These were each cut into 6 steaks that were randomly assigned (within LL) to 6 ageing periods (0, 3, 5, 8, 11 & 14 weeks). All steaks (n=144) were vacuum packaged and held at ~ 0.5°C. At the end of their assigned ageing period, each steak was tested for drip loss (DL), purge, standard plate count (SPC), ultimate pH, total water content, cook loss, shear force (SF), particle size (PS), vitamin E, intramuscular fat content (IMF) and CIE colour coordinates as per Holman et al. (2019). TVB-N was measured using a steam distillation method based on GB5009.228-2016 (NFSS, 2017). Data were analysed in Stata/IC version 14.2 (stata.com). SF data were log-transformed. The level of significance was set at 5%.

Results: Factor analyses were used to repartition the variance of all beef quality and spoilage parameters into distinct sources (factors), definable by the commonality of the high loading parameters. The first analysis was limited to 4 factors that accounted for 92.5% of the total variance. Factor 1 was defined by measures of colour; Factor 2 by microbial level and eating quality; Factor 3 by light scattering; and Factor 4 by chemical composition. Vitamin E was not loaded onto any of these factors. TVB-N was cross-loaded onto Factors 1 and 2, these accounting for 58.3% of total variance. The proximity of TVB-N to microbial parameters (purge, pHu & SPC) suggest a strong positive association. Likewise, the negative loading of TVB-N to the colour parameters (L*, a*, b*, hue & chroma) and eating quality parameters (PS, SF, DL & CL) suggest an antagonistic association. A second factor analysis excluded TVB-N from the model and resulted in the same 4 factors defined previously, accounting for 85.7% of total variance. Factor scores were calculated and then fitted into a regression model to predict TVB-N. The effects of Factor 1 (coefficient ± standard error: -0.37±0.08) and Factor 2 (-0.60±0.08) were found to be significant ($P<0.001$), having an $R2=0.40$. This result affirms the association observed between TVB-N and the high loading parameters used to define Factors 1 and 2.

Conclusion: TVB-N was associated with measures of beef colour, microbial count, and eating quality. IMF and vitamin E did not affect TVB-N – although these can impact on consumer perception. These findings suggest that TVB-N is a useful, but not comprehensive, freshness indicator for beef.

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Literature:

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