Effect of cooked beetroot juice and tomato paste in the color of nitrite-free cooked ham

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Introduction: Nitrite is an additive used in the meat products industry with multiple purposes, namely microbial inhibition, lipid oxidation prevention, and color formation. Nitrite was always problematic do to its potentially harmful effect on human health, namely its association with colon cancer (Fraqueza, Laranjo, Elias, & Patarata, 2021). The use of natural pigments, as betalain from beetroot and lycopene from tomato, has been studied in products made from meat emulsions, as smoked cooked-ham (Dias et al., 2020). Several studies approach the elimination of the chemical additive by replacing it with natural sources of nitrate and a reducing strategy to have nitrite available (Flores & Toldra, 2021). The aim of this work was to evaluate the potential of beetroot juice and tomato paste to achieve a sensorially accepted color in cooked ham (CH)

Material and methods: Five formulations of CH were prepared with the common ingredients 1.5% salt and 0.5% polyphosphate, and the variable ingredients (1) control; (2) 150 mg/kg $NaNO_2$ (3) 0.2% beetroot juice (BJ), (4) 1% BJ, (5) 5% tomato paste (TP). BJ was obtained with a centrifugal juicer from cooked beetroots, centrifuged in (10000 rpm, 10min, 4 °C), and lyophilized. Tomato paste was obtained by homogenizing cooked (20 min) tomatoes and stiffing the paste (1mm). The experiment was performed in triplicate, with pork leg meat from three different origins. Meat pieces were injected with the brine (4 °C) prepared to the concentration in the final product. The injection rate was 30%. After the injection, the meat was tumbled in a food processor (60 rpm; 10 min rotation, 1 hour resting; two cycles; 4 °C). The meat was stuffed into a polyamide bag, sealed, and cooked (72 °C, 10 min). The color (CIE L*a*b*) of CH slices was measured with a Konica Minolta Chroma Meter CR-400. The sliced CH were photographed and an online consumer test (135 consumers) was conducted to evaluate the appreciation of color, as previously described (Oliveira e Silva et al., 2020). The online questionnaire included a 9-point hedonic scale and a Just About Right (JAR) scale for color adequacy. L*a*b* and hedonic results were compared by ANOVA; penalty analysis was conducted for JAR data (XL-Stat, Addinsoft, Paris)

Results: The CH with nitrite presented a red color parameter (a*) of 9.31±0.66, which was higher ($p<0.05$) than the values measured in the control (6.89±0.76) and lower than those in the highest 1% of BJ (13.53±0.75). With the lower concentration of BJ the red color was 8.64±1.42, not different from the CH with nitrite. With tomato paste the a* values (7.78±0.55) were similar both to the control and to the nitrite CH.

The results from the consumer test were coherent with the color parameters. CH with nitrite had the higher hedonic evaluation, still similar to the CHs prepared with BJ. The color of the control CH was considered ideal only by 5.1% of the respondents. With tomato paste, consumers pointed out the color as pale or very pale. The CH prepared with nitrite had the maximum evaluation as ideal color (65%). With the lowest concentration of BJ the evaluation as an ideal was the second highest (50%), the threshold usually used with JAR scales to consider the formulation acceptable. The penalty analysis revealed a strong tendency of penalties due to the pale color in control and tomato CH, and due to the excessive color with the higher BJ concentration

Conclusions: The results of the present work revealed that a reduced concentration of BJ injected with the CH brine results in an acceptable color. There are other aspects to further study, namely the residual level of nitrate imparted by the BJ, as well as the stability of the color during the storage.

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