NEAR INFRARED REFLECTANCE SPECTROSCOPY IN THE PREDICTION OF NUTRITIONAL AND RHEOLOGICAL QUALITY TRAITS OF *BAUERNSPECK*

S. Balzan*[1], F. Blaas[2], L. Serva[3], M. Mirisola[3], V. Giaccone[1], I. Andrighetto[3], S. Segato[3] and E. Novelli[1]

[1] Department of Public Health, Comparative Pathology and Veterinary Hygiene, University of Padova, 35020 Legnaro (PD), Italy. [2] Technical bearing for mountain agriculture, Autonomy Province of Bolzano, 39100 Bolzano (BZ), Italy. [3] Department of Animal Science, University of Padova, 35020 Legnaro (PD), Italy. Email: stefania.balzan@unipd.it

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Introduction

Bauernspeck is a typical smoked and salted meat product of the South Tyroler Region (North Italy), made following the tradition and the custom of this mountain area. It is a pork product made of ham, shoulder, loin-belly or the entire half carcass, with rind and subcutaneous fat. After deboning, primal cuts are cured with salt and spices (frequently with sodium nitrite), smoked and ripened up to 4–8 months. At the end of processing it shows peculiar rheological and gustative characteristics. In order to improve quality control assessment, conventional determinations may be integrated with alternative analytical methods. Near infrared reflectance spectroscopy (NIRs) is a rapid, low cost and non-destructive method of analysis widely used to assess proximate composition of meat and fish (Cozzolino *et al.*, 2002). The aim of this study was to evaluate NIRs performance in the prediction of proximate composition and salt content of *Bauernspeck*. Moreover, for the muscular fraction (*Longissimus dorsi*, LD) the ability of NIRs to predict some ripening quality traits such as pH, water activity, proteolysis index, meat colour and firmness was evaluated.

Materials and Methods

The study examined 120 pigs reared in 2 farms of the province of Bolzano (Italy). Animals were equally divided between castrated and female and consisted of three different crossbreeds. The pigs were slaughtered at a live weight of 132.4±12.8kg. Primal cuts were randomly sent to six local manufacturers where they were submitted to a ripening productive process according to their own traditional method. After a period of 4 months of ripening on average, samples (n=120) of loin (*Longissimus dorsi*, rind and backfat included) were collected as 1.5cm thick whole slice (WS) and as lean cut (*Longissimus dorsi*, LD only). The WS and LD samples were analysed for proximate composition: moisture, crude protein (CP), ether extract and ash according to A.O.A.C. (2000). Salt content (% NaCl) was determined as reported by Meynier *et al.* (1999); in LD samples, non-protein nitrogen (NNP) (Meynier *et al.*, 1999) and instrumental colour (CIE L*a*b*) by means of Minolta RIO-TNE-005 (Minolta Camera Co. Ltd, Japan) were also measured. The pH was measured after homogenisation of sample in distilled water (1/10 w/v); water activity (A_w) determination was performed using an Aqualab CX-2 (Decagon). Firmness was measured with a Carcass Fat Hardness Meter 006. All samples were minced then scanned in duplicate by a FOSS NIRSystem 5000 (1100-2498 nm, gap 2nm). Spectra were recorded as log1/R averaging 32 scans of the sample after 16 scans of the white reference. Original spectra were interpolated every 2nm.WinISI 1.5 was used to acquire spectral data and to perform calibration adopting the modified PLS method of ISI. Spectra math treatments included scatter correction (standard normal variate and detrending), second derivative with gaps and smoothing between 5 data points. Evaluation of performances was based on the SEC standard error of calibration, SECV = standard error of cross validation, 1-VR = one minus variance ratio (Shenk and Westerhaus, 1993).

Results and Discussion

Chemical and rheological parameters considered in this study represented the main quality traits to assess the economic value of *Bauernspeck*. Moreover, A_w, moisture/crude protein ratio and NaCl/moisture ratio have been included in the voluntary regulation of production. Chemical composition of LD and WS are given in Table 1 and 2, respectively. *Bauernspeck* is a meat product characterised by a low moisture content and a fair variability in the fat percentage especially when the WS is considered. As reported in Table 1 for dry-cured LD the value of the R^2 of cross validation (1-VR) ranged from 0.34 to 0.99 suggesting an effective prediction for some of these parameters. The NIRs technique showed good accuracy in the prediction of proximate composition both for lean samples and fatter samples. These results were partially expected because of the low moisture percentage. In fact, high moisture levels (above 50%) influence the wavelength range over which the instrument can provide reliable analysis (Williams, 2002). Data reported in Table 2 confirmed the great accuracy in the prediction of proximate composition. The higher fat content of the WS was not detrimental as evidenced by 1-VR values which were still very high, except for NaCl content. The slight decrease in the prediction of this latter chemical parameter was probably due to the increasing value of fat content that caused the dilution of salt. A high fat content could also produce a lipidic film that probably limited the absorbance of incident light.

Table 1: Performance of calibration for the lean portion of *Bauernspeck* (only *Longissimus dorsi*). SD: standard deviation; SECV: standard error for cross validation; 1-VR: fraction of explained variance; CV(%): (SEVC/mean)x100.

(LD) samples	Mean ± SD	SECV	1-VR	CV(%)
Moisture, %	38.8 ± 6.3	0.1	0.99	0.3
Crude protein, %	48.9 ± 6.3	0.1	0.99	0.3
Ether extract, %	4.8 ± 1.8	0.1	0.99	0.5
Ash, %	7.4 ± 1.4	0.1	0.99	1.8
Moisture/crude protein	0.8 ± 0.2	0.1	0.99	1.5
NaCl, %	6.5 ± 1.2	0.4	0.89	6.5
NaCl/moisture	17.0 ± 4.2	1.1	0.93	6.7
Proteolysis index (NNP/CP)	9.00 ± 1.87	0.80	0.82	8.9
pH	6.13 ± 0.36	0.10	0.92	1.7
Water activity (A_w)	0.85 ± 0.05	0.01	0.98	0.8
Lightness (L*)	31.26 ± 4.97	3.66	0.47	11.7
Redness (a*)	5.02 ± 1.91	1.57	0.34	31.2
Yellowness (b*)	8.03 ± 2.16	2.01	0.14	25.0
Firmness, 0-1000 points	900 ± 90	49	0.72	5.4

Table 2: Performance of calibration for whole slice (WS) *Bauernspeck*.

(WS) samples	Mean ± SD	SECV	1-VR	CV(%)
Moisture, %	25.2 ± 5.8	0.4	0.99	1.6
Crude protein, %	25.8 ± 5.4	0.6	0.99	2.2
Ether extract, %	44.1 ± 11.3	0.8	0.99	1.8
Ash, %	4.4 ± 0.9	0.2	0.95	4.7
NaCl, %	4.4 ± 1.0	0.4	0.84	8.9

Good accuracy in the prediction of rheological parameters such as pH, A_w and proteolysis index was observed. Firmness was characterised by a medium performance magnitude, which probably could be enhanced by increasing the dataset. Poor performances were observed for colour instrumental data (1-VR: 0.14-0.47) attributable to the wavelength range (of the near infrared spectrum) which was unsuitable for this aim.

Conclusions

Results obtained from this research showed that proximate composition, physical and rheological traits of *Bauernspeck* can be successfully monitored by NIRs. Considering the importance of non protein nitrogen associated with moisture, salt, A_w and fat for the quality characterization of dry cured meat products (Schivazappa *et al.*, 2002), our results suggest that NIRs could be used as a rapid instrument to assess their ripening parameters and quality traits too. The determination of salt and fat content and proteolysis index are time consuming; thus the availability of NIRs as a rapid method for their measurement could improve the control of the productive process both reducing time and cost of analysis.

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