Pork fat evaluation system by near infrared spectroscopy

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Introduction

A pork fatty acid composition evaluation system by NIR spectroscopy with appropriate performance is normally developed by retrieving data measured by a high grade, but expensive NIR instrument. The proposed procedure for the development involves using hardware specifications from the high grade NIR instrument to design and build a new low-cost NIR instrument that would be applicable for limited purposes. Necessary characteristics of the NIR instrument for the purpose i.e. wavelength range, wavelength resolution, S/N ratio, wavelength stability, linearity and other parameters can be examined by this method, and the specifications from which the new instrument can be built can be decided, and the instrument built accordingly.[1]

Materials and methods

Fatty acid composition (i.e. saturated fatty acid, oleic acid, mono unsaturated fatty acid and poly-unsaturated fatty acid) is one of the most important parameters of pork meat quality.[2–4] Recently oleic acid is considered to be a very important constituent of pork meat. By measuring the amount of oleic acid, pork meat can be correctly evaluated. Farmers can assess the appropriate price, and the consumers can get reliable quality for the price.

It has been difficult to measure all pork meat at the market-place because of the tedious procedure of chemical fatty acid measurement method, i.e. gas chromatography. Using NIR measurement, it should become possible to measure pork meat on-site at the market-place.

A procedure for developing a new NIR instrument is described here. We developed such a specialised NIR instrument to realise the evaluation of pork meat, following the procedure described in Figure 1, which we think is efficient.

First, we measure 60 samples of pork fat by an NIR spectrometer Model "XDS" (manufactured by Foss). Next we evaluate the calibration developed from these spectra. If the results are not good, measuring conditions must be optimised, i.e. wavelength area, optics for measurement (i.e. transmittance, reflectance or interactance etc.) and other measuring parameters, such as integration time, averaging time and others, until a good calibration is achieved.

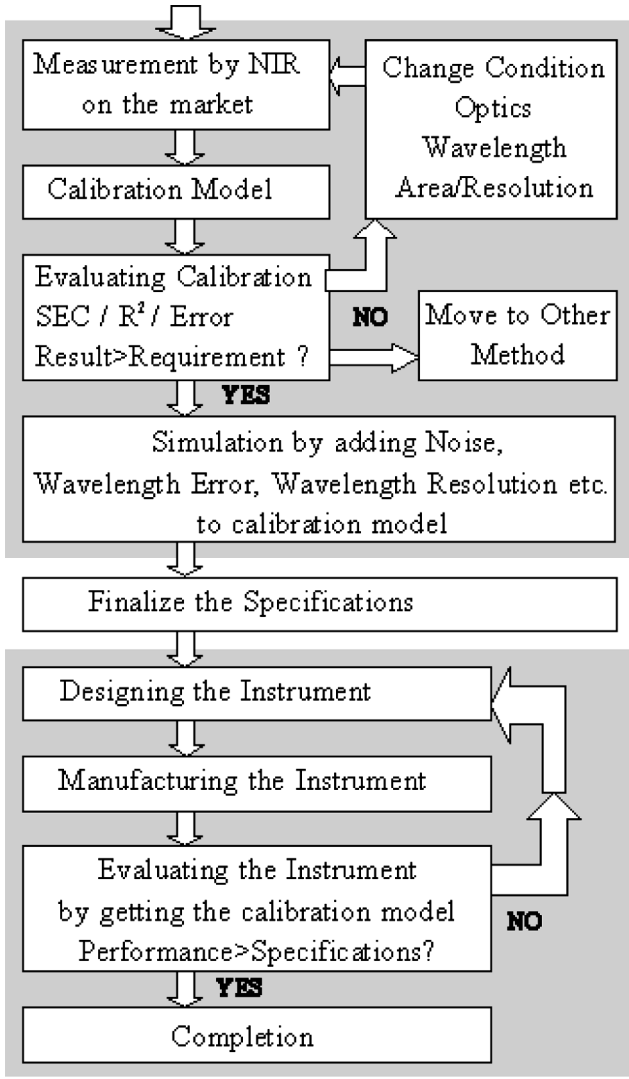

Figure 1. Procedure of Designing a NIR spectrometer.

The next step comes after a satisfactory calibration is obtained. The measured data are modified to evaluate the influence of the parameter to be decided. By adding various amplitudes of noise and getting further calibrations from such modified data, the relationships can be evaluated e.g. between correlation factors vs. noise, and error vs. noise. Using this approach different measuring conditions can be evaluated.

In the third step, from the results of the relationships between the performance and the measuring conditions, the hardware specifications can be specified according to specific requirements, e.g. correlation factor (R) better than 0.7, error (SEP) less than 3% (in the case of oleic acid content).

Table 1. Specifications.

Item	Specifications
Wavelength Range	700 – 1000 nm
Wavelength Resolution	10nm
Wavelength Stability	<0.5 nm
Noise	<50 uABS
Linearity	<10%

Finally as the last step, the new instrument is designed according to the hardware specifications decided, and built. If the performance of the newly-developed instrument reaches the required specifications, the implementation will have been satisfactory.

Results and discussion

In this experiment the derived specifications are given in Table.1. All the items in Table 1 were derived by evaluating the influence of the parameters to correlation (*R*) and error (*SEP*), and a new NIR system was built according to these specifications.

The system developed is shown in Figure 2. We used a spectrometer with a grating, and silicon linear array detector. As a light source five small halogen lamps were used.

Performance of this NIR instrument was considered to be sufficient for inspecting and grading pork meat. One of the most important parameters that influences such an instrument is the S/N ratio. The specifications should include a S/N ratio less than 50 micro ABS, and the designed instrument had a S/N ratio around 45 micro ABS. Other parameters also satisfied the specifications.

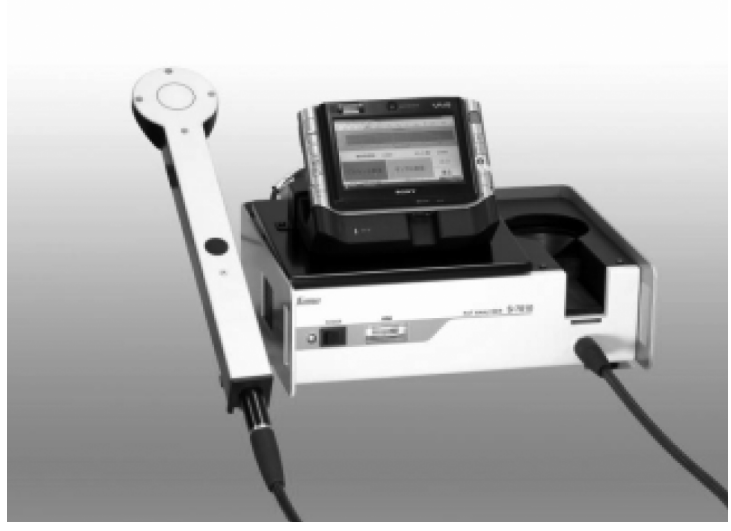

Figure 2. Developed instrument.

Table 2. Result of analysis.

Item	Sample		Measured	
	Average %	Dev %	R	SEP %
SFA (Saturated Fatty Acid)	48.20	3.52	0.93	1.22
MUFA (Mono Unsaturated Fatty Acid)	40.46	3.20	0.77	1.98
PUFA (Poly Saturated Fatty Acid)	11.34	3.20	0.88	1.44
Oleic Acid	38.64	3.04	0.82	1.65

The performance of the instrument met the required specifications of $R > 0.7$ and $SEP < 3\%$. The performance of the instrument is given in Table 2.

Four types of fatty acid were measured and the error was smaller than 3%, which was considered to be satisfactory to estimate the fat quality of pork. Measuring time was around 3 sec. which is short enough for routine on-site measurements of meat.

Conclusion

The procedure described for the development of a NIR instrument for carrying out simple testing procedures was considered to be effective and useful. Using the procedure we were able to develop a new NIR instrument which had performance that was considered to be satisfactory for grading pork meat. Using such an instrument, all the pork meat could be evaluated and priced accordingly on site in the market-place.

References

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