

**Establishing acceptable rancidity levels in meat products through analytical methods is trickier than taste panels, but relating the results obtained for the different techniques might lead to better interpretation of analytical results in the future.**

By Robert Levermore

# Rancidity in fresh and stored pork products

**A** number of analytical methods for measuring rancidity are available to the food analyst and information does exist on rancidity measurements in meat or meat products. However, while these analytical methods are all of use in the measurement of rancidity in foods, sensory analysis is the definitive test of the condition of a food. Rancidity is a question of off-flavour and/or off-odour, and therefore if a product smells or tastes rancid, it is rancid. Unfortunately, the organisation of

taste panels can be expensive and impractical in many instances. It is therefore common practice in industry to use simple analytical tests in preference to sensory analysis to determine the quality of meat. However, little or no definitive data relating the analytical results obtained from rancidity measurements to the condition of the meat analysed is currently available. This means that any decisions made on the condition of meat based on rancidity measurements must rely solely on the analyst's previous

experience with the product, rather than being judged against a defined value. Because of this, it would be advantageous for industry to establish specific values or value ranges for these tests that could be used to determine whether specific meat products were acceptable or rancid. To this end, sensory and chemical analyses were carried out at CCFRA on samples of meat to determine 'critical values' for the most commonly used chemical analyses for the point that pork samples became unacceptable for consumption due to rancidity.

## Rancidity parameters

The parameters most usually measured to determine the condition of meat with regard to rancidity are peroxide value (PV), free fatty acid (FFA) content and thiobarbituric acid (TBA) number. The methods used to calculate these values all have their advantages and disadvantages.

Peroxide values measure the amount of peroxides contained in the fat. The analysis must be carried out on a pure fat sample, which is typically extracted from the meat sample being analysed by solvent extraction. Peroxides do not themselves possess sensory characteristics associated with rancidity, but are intermediate reaction products, which will react further to form the odorous aldehydes and ketones indicative of oxidative rancidity. However, as the first products formed by the oxidation of fats are peroxides, the peroxide value is a commonly used method of measuring oxidative rancidity. Peroxide formation during storage is slow at first during an induction period, the length of which will depend on the nature of the fat and the presence of antioxidants, after which the rate of formation increases rapidly. The peroxide value is a useful guide to the quality of a saturated

fat, but is of less use in assessing the quality of highly unsaturated fats. This is because the peroxides initially formed from unsaturated fats are themselves highly unsaturated and thus unstable and react quickly to form secondary oxidation products. The amount of peroxide present therefore remains low relative to that in saturated fats, even after extensive oxidation. Low peroxide values may also be obtained for any extremely rancid products, again because the peroxides initially formed have all undergone further oxidation reactions.

Free fatty acid content is a measure of the extent to which hydrolytic rancidity has occurred in a sample. As with PV analysis, it must be carried out on a sample of the fat from the food. Hydrolytic rancidity is caused by hydrolysis of the triglycerides in the food, in the presence of moisture and normally a catalyst such as a lipase or esterase enzyme, which gives rise to the liberation of free fatty acids. FFA content is used extensively as a general indication of the condition and edibility of pure oils and fats and the fat extracted from food products, including meat. However, while the FFA content of most oils and fats increases during storage relative to rancidity, in some instances, particularly with refined oils, this may not be the case. Such oils may undergo oxidative rancidity to a far greater extent than hydrolytic rancidity. For this reason, as with PV analyses, care must be taken when interpreting the results obtained.

The extent of oxidative rancidity in a fat may also be determined by its TBA number, which is an expression of the amount of malonaldehyde present. Unlike FFA and PV analyses, TBA analysis is carried out directly on the food sample being tested, with no preliminary fat extraction step

Table 1. Mean results for belly pork								
Sampling Date	Chemical Results						Sensory Results	
	PV (meq/kg)		FFA (% oleic acid)		TBA No.		Rancidity	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
On Receipt	1.4	0.9-2.1	0.37	0.30-0.45	0.25	0.16-0.38	0	0
Use-by Date	1.9	1.4-2.5	0.50	0.24-0.73	0.28	0.17-0.37	0	0
First Sign of Rancidity	3.2	1.0-5.9	0.74	0.55-1.10	0.76	0.36-1.63	1.3	1-2
Advanced State of Rancidity	2.5	1.6-3.1	1.43	1.05-1.73	0.50	0.31-0.70	4.4	4-5

Table 2. Mean results for cooked crispy bacon								
Sampling Date	Chemical Results						Sensory Results	
	PV (meq/kg)		FFA (% oleic acid)		TBA No.		Rancidity	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
On Receipt	2.7	1.2-6.4	0.87	0.75-1.09	2.17	1.64-2.47	0	0
Use-by Date	3.0	1.8-4.8	0.79	0.70-0.94	2.29	1.77-2.85	0	0
First Sign of Rancidity	65.3	8.7-152	1.10	0.55-1.73	4.08	3.04-5.01	3.8	1-6
Advanced State of Rancidity	5.5	3.6-8.8	0.80	0.65-0.90	2.19	1.96-2.58	1	0-3

Table 3. Mean results for streaky bacon								
Sampling Date	Chemical Results						Sensory Results	
	PV (meq/kg)		FFA (% oleic acid)		TBA No.		Rancidity	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
On Receipt	16.3	10.7-20.3	0.83	0.46-1.27	0.30	0.15-0.36	0	0
Use-by Date	12.3	7.6-19.6	1.15	0.90-1.52	0.15	0.10-0.21	0	0
First Sign of Rancidity	11.3	6.8-15.2	2.15	1.14-3.07	0.27	0.19-0.42	4	3-5
Advanced State of Rancidity	19.1	13.4-21.8	2.20	0.83-3.48	0.26	0.20-0.35	2.3	1-4

required. Typically, the TBA number of a sample shows a steady increase as it becomes more rancid, but a certain amount of variation is found between the TBA numbers obtained for similar fresh samples. Studies of the TBA analysis method found that the TBA values for individual samples showed a steady increase with increasing rancidity, but that variable results were obtained when comparing similar fresh samples.

### Rancidity in pork products

Samples of belly pork, streaky bacon and cooked crispy bacon were chosen for analysis, as rancidity in pork and pork products is known to be a source of problems in the industry. Sensory analyses and PV, FFA, and TBA determinations were carried out on the samples at various states throughout their storage life ranging from fresh to advanced stages of rancidity. The data were

**Table 4. Decision points**

Product	Method	Equal Risk Decision point	Risk of Misidentification
Belly Pork	PV	1.95 meq/kg	25%
	FFA	0.59%	13%
	TBA no.	0.33	20%
Cooked Crispy Bacon	PV	3.72 meq/kg	27%
	TBA no.	2.46	22%
Streaky Bacon F	FA	1.31 %	15%

analysed to relate the chemical and sensory data and attempt to determine value ranges for the PV, FFA and TBA analyses for acceptable and unacceptable product.

The sample results obtained for each product type (shown in Tables 1-3) at each sampling occasion were separated into groups defined as acceptable and unacceptable based on their rancidity as perceived by sensory analysis. All samples with a mean rancidity score of 1 or more were classified as unacceptable. Normal distributions were then formed from the sample results to determine whether a significant difference existed between the acceptable and unacceptable samples. For those combinations of sample and analytical method that did show significant differences between acceptable and unacceptable samples, further statistical analysis was carried out to attempt to determine 'decision points' (Table 4). These are analytical values that could be defined as the point at which an acceptable sample becomes unacceptable.

For each of the product types and each chemical analysis method employed, the mean values obtained for unacceptable samples (taken at the first sign of rancidity and at an advanced state of rancidity) showed an increase compared with the mean values obtained for acceptable products (taken on receipt and at the use-by date). However, in a number of cases, the variation between repli-

cates meant that the difference between the results for acceptable and unacceptable products was not significant. This meant that these results could not be used to reliably distinguish between acceptable and unacceptable products. This was the case for free fatty acid content analysis of cooked crispy bacon, and peroxide value and TBA number analysis for streaky bacon. None of the three methods used were found to produce results that showed a significant difference between acceptable and unacceptable samples for all of the products tested. This was not unexpected, as while all three tests measure rancidity, they do so by measuring different reaction products and these products will be produced in different proportions by different food-stuffs. It is for this reason that the measurement of rancidity by non-sensory methods is at present such an imprecise science.

Further statistical analysis carried out on the results demonstrated significant differences between acceptable and unacceptable product, and decision points were calculated. These are defined analytical result values by which samples may be classified as acceptable or unacceptable. The decision points were calculated to a specified supplier risk, a specified consumer risk, or to the point where the risks to supplier and consumer were equal. Supplier risk is defined as the risk of misidentifying an

acceptable product as unacceptable. Consumer risk is the risk of misidentifying an unacceptable product as acceptable. With the objective of determining the points at which the products become unacceptable due to rancidity, the decision point equalising the risks is of most relevance.

## Trial results

For the results of the trial, the decision point values obtained were the best approximation of the values at which these particular meat products become unacceptable due to rancidity. However, the risks of misidentification are higher than would be desirable if these values were to be relied upon for quality control purposes. One possible way to diminish this risk would be to analyse the samples being tested using more than one type of method, where more than one has proven to be suitable. Another way would be to carry out multiple extractions and analyses or multiple analyses of a single extract of samples, thus reducing the uncertainty of the results and decreasing the likelihood of error.

The work carried out has demonstrated an approach to the determination of analytical values for the indication of rancidity in meats by chemical analysis. Further trials carried out as detailed in this report could be used to determine rancidity decision points for other food products. Where suitable confidence levels were obtained, these decision points could be used in the routine analysis of samples, either as part of an integrated quality control procedure during food production or for swift and reliable analysis of complaint and suspect food samples. **MI**

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