

Meat technology – information sheet

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Microwave Method for Chemical Lean Determination

This method of chemical lean (CL) testing relies on the fact that there is a fixed relationship between moisture and fat in boneless meat and therefore a fixed relationship between moisture and CL.

Samples of meat are dried in a microwave oven and the loss of weight on drying is expressed as percent moisture content. The known relationship between moisture and CL content in boneless meat is used to estimate the chemical lean of the sample.

This method may be used to determine the CL content of fresh and frozen meat.

Method

Equipment

- Mincer with 6 mm and 3 mm plates OR heavy duty food processor, or a combination of the two
- Balance with at least 0.1 g-sensitivity
- Microwave oven with 600-700 watt microwave energy output, turntable and electronic timer (manual timers are not sufficiently accurate)

- Polypropylene beakers of approximately 150 to 200 mL capacity or glass beakers, 250 mL capacity
- Desiccator with silica gel desiccant (optional)
- Open weave disposable kitchen cloth e.g. Chux cut into squares to cover the top of the beakers, plus elastic bands to hold the cloths in place over the tops of the beakers
- Silicon Carbide (carborundum) finely ground
- Sand or salt

Procedure

1. Prepare the sample by mincing, or chopping in a food processor/blender.
2. Preheat the microwave oven. If the oven has a convection heating element, it can be preheated by switching on the element for a few minutes. If there is no heating element, the oven may be preheated by placing a beaker containing about 500g of a mixture of 10% silicon carbide in sand or salt on the centre of the turntable and switching on the microwave power for about 5 minutes. (The beaker of carborundum and sand should be left in the oven even when the samples are put in the oven.)



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3. Dry the beakers and squares of Chux cloth cut to cover the tops of the beakers by heating them in the microwave oven for about one minute.
4. When a new microwave oven is used it must be calibrated to determine the heating time necessary to completely dry the samples in the microwave oven. The same must be done if a difference sample load is dried at anytime i.e. 4 x 20 g samples will need more time than 2 x 20 g samples (but not twice as much).

The correct drying time is the minimum time required to remove all the moisture from the sample. The drying time will change according to the particular oven used, the sample size, and the number of samples in the oven. See below for the procedure to calibrate the microwave oven.

5. Weigh an empty beaker plus Chux cloth and elastic band. Weigh 20 g of homogenised meat sample in the beaker. Spread the sample into a thin layer around the lower wall of the beaker with a spatula or spoon. Accurately weigh the beaker plus sample plus Chux to ensure that there is 20.0 g sample in the beaker. Place the Chux cloth over the top of the beaker with an elastic band to hold it in place.

There is an alternative to weighing exactly 20.0 g of sample. If a sample of 20.0 g is weighed exactly, the subsequent determination of moisture content is simplified. However, if the weight of the sample is accurately known (even if it is not exactly 20.0 g) the moisture content can be calculated using the formula that follows (page 4).

Either glass or disposable polypropylene beakers may be used. If polypropylene beakers are used, it may be necessary to use a reduced power setting on the microwave oven to avoid creating a hole in the beaker. The reduction in power will extend the drying time.

6. Place the duplicate samples in the preheated oven. The samples should

be spaced at equal distances around the turntable. The Chux cloths are intended to stop fat from splattering out of the beaker.

Dry the duplicate samples for the predetermined time.

7. Cool the samples sufficiently to enable them to be transferred by hand to the balance. Cooling may be done in a desiccator if ambient conditions are such (e.g. very humid) that moisture is likely to be picked up by the sample as it cools.

Any suitably sized enclosed container e.g. a 4-litre ice cream container, can be used as a desiccator. The bottom of the container should be covered with silica gel desiccant, and the colour of the desiccant should be maintained as blue. When the desiccant starts to turn to pink it can be regenerated by heating it in the microwave oven for a few minutes. (If the desiccant is put in the oven in a plastic container, use a low power setting to avoid melting the container.)

Weigh and calculate chemical lean (page 4).

Note: The method requires that each analysis is carried out in duplicate. This is to ensure that the sample preparation and testing is consistent. If the difference between duplicate moisture test results is 1% or less (1.2 CL units), the results can be averaged. If the difference between duplicates is more than 1% moisture, at least one of the duplicates is unreliable. The test should be repeated in order to accurately determine % CL.

Samples can be tested in triplicate. If the spread of results from triplicates is 1% moisture (1.2 CL units) or less, the three results can be averaged.

If the spread of results from triplicates is 1.1% moisture or more, and the spread between two results is less than 0.5% moisture, the two close results can be averaged and the third discarded.

If the spread results from triplicates is 1.1%

moisture or more and the spread between each replicate is 0.5% or more, the sample should be retested.

Calibration of the Microwave Oven

To determine the correct drying time, dry the selected sample load to constant weight. (Use the same number and weight of sample to be used in subsequent tests).

Choose a time, say 5 minutes, for 2 x 20 g samples and dry the sample accordingly.

Allow them to cool sufficiently so that they can be transferred by hand to the balance.

Weigh the samples.

Return them to the oven and dry them for a further 60 seconds, then re-weigh.

If a sample has lost weight, repeat the exercise on fresh samples. Dry the sample for 5 minutes and 30 seconds.

If a sample has again lost weight, repeat the exercise – this time for 6 minutes – and continue this procedure until a sample loses no more weight following the extra 60 seconds in the oven.

When the weight loss ceases, repeat the exercise again but reduce the drying time by 15 seconds, i.e. if the samples that were dried for 6 minutes lost no more weight by drying them for a further 60 seconds, reduce the drying time of the next samples to 5 minutes 45 seconds.

Weight them and again dry them for a further 60 seconds to see if further weight is lost.

Using this procedure, the required drying time can be determined to within 15 seconds. This time should be adhered to because both under-drying and over-drying will lead to errors in determining % CL.

Samples should be visually checked after they have been dried to confirm that the drying time is appropriate. If there is any sign of condensed water droplets in the beaker or if any part of the meat sample is soft or pliable, the drying time is insufficient. If the bottom of the meat sample is black and charred, the drying time or temperature is excessive.

The microwave power can be monitored by regularly measuring the amount of water evaporated in a fixed time. Weigh 100 mL of tap water in a beaker and heat the water in the microwave oven for 5 minutes. Remove the beaker and weigh it to determine how much water has evaporated. This test should be done once a week and if the weight of water evaporated reduces by more than 10%, or if there is a reduction in the amount of water evaporated over two successive tests, the oven should be recalibrated or replaced.

It is not necessary to regularly recalibrate the microwave oven. However, the power of the magnetron in domestic units may deteriorate with extensive use and an occasional retesting of the calibration is warranted. Retesting is best done if errors in test results are suspected following check-testing of the microwave results against standard Soxhlet tests. These Soxhlet tests should be carried out by another (independent) laboratory. These check tests should be done regularly as a routine check on the results being produced during normal production.

Calculation

Weight of beaker plus Chux and elastic band (g) = A

Weight of beaker plus Chux and elastic band plus sample (g) = B

Weight of beaker plus Chux and elastic band plus sample after drying (g) = C

$$\% \text{ Moisture} = \frac{(B - C)}{(B - A)} \times 100$$

Use the formulae below to determine the chemical lean content of the sample
OR

Refer to Tables 1, 2 and 3

BEEF (refer Table 1)

[CL 80% or greater] Chemical lean % = (% water x 1.21) + 5.44

[CL 79% or lower] Chemical lean % = (% water x 1.35) - 3.2

MUTTON (refer Table 2)

[All product] Chemical lean % = (%water x 1.25) + 2.7

PORK (refer Table 3)

[All product] Chemical Lean % = (%water x 1.27) + 1.1

Fat content % = 100% minus Chemical lean %

Table 1 Percentage chemical lean contents of boneless beef microwave water contents in the range 33.0 – 73.9%

Water content	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
33	41.4	41.5	41.6	41.8	41.9	42.0	42.2	42.3	42.4	42.6
34	42.7	42.8	43.0	43.1	43.2	43.4	43.5	43.6	43.8	43.9
35	44.1	44.2	44.3	44.5	44.6	44.7	44.9	45.0	45.1	45.3
36	45.4	45.5	45.7	45.8	45.9	46.1	46.2	46.3	46.5	46.6
37	46.8	46.9	47.0	47.2	47.3	47.4	47.6	47.7	47.8	48.0
38	48.1	48.2	48.4	48.5	48.6	48.8	48.9	49.0	49.2	49.3
39	49.5	49.6	49.7	49.9	50.0	50.1	50.3	50.4	50.5	50.7
40	50.8	50.9	51.1	51.2	51.3	51.5	51.6	51.7	51.9	52.0
41	52.2	52.3	52.4	52.6	52.7	52.8	53.0	53.1	53.2	53.4
42	53.5	53.6	53.8	53.9	54.0	54.2	54.3	54.4	54.6	54.7
43	54.9	55.0	55.1	55.3	55.4	55.5	55.7	55.8	55.9	56.1
44	56.2	56.3	56.5	56.6	56.7	56.9	57.0	57.1	57.3	57.4
45	57.6	57.7	57.8	58.0	58.1	58.2	58.4	58.5	58.6	58.8
46	58.9	59.0	59.2	59.3	59.4	59.6	59.7	59.8	60.0	60.1
47	60.3	60.4	60.5	60.7	60.8	60.9	61.1	61.2	61.3	61.5
48	61.6	61.7	61.9	62.0	62.1	62.3	62.4	62.5	62.7	62.8
49	63.0	63.1	63.2	63.4	63.5	63.6	63.8	63.9	64.0	64.2
50	64.3	64.4	64.6	64.7	64.8	65.0	65.1	65.2	65.4	65.5
51	65.7	65.8	65.9	66.1	66.2	66.3	66.5	66.6	66.7	66.9
52	67.0	67.1	67.3	67.4	67.5	67.7	67.8	67.9	68.1	68.2
53	68.4	68.5	68.6	68.8	68.9	69.0	69.2	69.3	69.4	69.6
54	69.7	69.8	70.0	70.1	70.2	70.4	70.5	70.6	70.8	70.9
55	71.1	71.2	71.3	71.5	71.6	71.7	71.9	72.0	72.1	72.3
56	72.4	72.5	72.7	72.8	72.9	73.1	73.2	73.3	73.5	73.6
57	73.8	73.9	74.0	74.2	74.3	74.4	74.6	74.7	74.8	75.0
58	75.1	75.2	75.4	75.5	75.6	75.8	75.9	76.0	76.2	76.3
59	76.5	76.6	76.7	76.9	77.0	77.1	77.3	77.4	77.5	77.7
60	77.8	77.9	78.1	78.2	78.3	78.5	78.6	78.7	78.9	79.0
61	79.2	79.3	79.4	79.6	79.7	79.8	80.0	80.1	80.2	80.4
62	80.5	80.6	80.7	80.8	80.9	81.1	81.2	81.3	81.4	81.5
63	81.7	81.8	81.9	82.0	82.2	82.3	82.4	82.5	82.6	82.8
64	82.9	83.0	83.1	83.2	83.4	83.5	83.6	83.7	83.8	84.0
65	84.1	84.2	84.3	84.5	84.6	84.7	84.8	84.9	85.1	85.2
66	85.3	85.4	85.5	85.7	85.8	85.9	86.0	86.1	86.3	86.4
67	86.5	86.6	86.8	86.9	87.0	87.1	87.2	87.4	87.5	87.6
68	87.7	87.8	88.0	88.1	88.2	88.3	88.4	88.6	88.7	88.8
69	88.9	89.1	89.2	89.3	89.4	89.5	89.7	89.8	89.9	90.0
70	90.1	90.3	90.4	90.5	90.6	90.7	90.9	91.0	91.1	91.2
71	91.4	91.5	91.6	91.7	91.8	92.0	92.1	92.2	92.3	92.4
72	92.6	92.7	92.8	92.9	93.0	93.2	93.3	93.4	93.5	93.6
73	93.8	93.9	94.0	94.1	94.3	94.4	94.5	94.6	94.7	94.9

Table 2 Percentage chemical lean contents of boneless mutton microwave water contents in the range 35.0 – 69.9%

Water content	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
35	46.5	46.6	46.7	46.8	47.0	47.1	47.2	47.3	47.5	47.6
36	47.7	47.8	48.0	48.1	48.2	48.3	48.5	48.6	48.7	48.8
37	49.0	49.1	49.2	49.3	49.5	49.6	49.7	49.8	50.0	50.1
38	50.2	50.3	50.5	50.6	50.7	50.8	51.0	51.1	51.2	51.3
39	51.5	51.6	51.7	51.8	52.0	52.1	52.2	52.3	52.5	52.6
40	52.7	52.8	53.0	53.1	53.2	53.3	53.5	53.6	53.7	53.8
41	54.0	54.1	54.2	54.3	54.5	54.6	54.7	54.8	55.0	55.1
42	55.2	55.3	55.5	55.6	55.7	55.8	56.0	56.1	56.2	56.3
43	56.5	56.6	56.7	56.8	57.0	57.1	57.2	57.3	57.5	57.6
44	57.7	57.8	58.0	58.1	58.2	58.3	58.5	58.6	58.7	58.8
45	59.0	59.1	59.2	59.3	59.5	59.6	59.7	59.8	60.0	60.1
46	60.2	60.3	60.5	60.6	60.7	60.8	61.0	61.1	61.2	61.3
47	61.5	61.6	61.7	61.8	62.0	62.1	62.2	62.3	62.5	62.6
48	62.7	62.8	63.0	63.1	63.2	63.3	63.5	63.6	63.7	63.8
49	64.0	64.1	64.2	64.3	64.5	64.6	64.7	64.8	65.0	65.1
50	65.2	65.3	65.5	65.6	65.7	65.8	66.0	66.1	66.2	66.3
51	66.5	66.6	66.7	66.8	67.0	67.1	67.2	67.3	67.5	67.6
52	67.7	67.8	68.0	68.1	68.2	68.3	68.5	68.6	68.7	68.8
53	69.0	69.1	69.2	69.3	69.5	69.6	69.7	69.8	70.0	70.1
54	70.2	70.3	70.5	70.6	70.7	70.8	71.0	71.1	71.2	71.3
55	71.5	71.6	71.7	71.8	72.0	72.1	72.2	72.3	72.5	72.6
56	72.7	72.8	73.0	73.1	73.2	73.3	73.5	73.6	73.7	73.8
57	74.0	74.1	74.2	74.3	74.5	74.6	74.7	74.8	75.0	75.1
58	75.2	75.3	75.5	75.6	75.7	75.8	76.0	76.1	76.2	76.3
59	76.5	76.6	76.7	76.8	77.0	77.1	77.2	77.3	77.5	77.6
60	77.7	77.8	78.0	78.1	78.2	78.3	78.5	78.6	78.7	78.8
61	79.0	79.1	79.2	79.3	79.5	79.6	79.7	79.8	80.0	80.1
62	80.2	80.3	80.5	80.6	80.7	80.8	81.0	81.1	81.2	81.3
63	81.5	81.6	81.7	81.8	82.0	82.1	82.2	82.3	82.5	82.6
64	82.7	82.8	83.0	83.1	83.2	83.3	83.5	83.6	83.7	83.8
65	84.0	84.1	84.2	84.3	84.5	84.6	84.7	84.8	85.0	85.1
66	85.2	85.3	85.5	85.6	85.7	85.8	86.0	86.1	86.2	86.3
67	86.5	86.6	86.7	86.8	87.0	87.1	87.2	87.3	87.5	87.6
68	87.7	87.8	88.0	88.1	88.2	88.3	88.5	88.6	88.7	88.8
69	89.0	89.1	89.2	89.3	89.5	89.6	89.7	89.8	90.0	90.1

Table 3 Percentage chemical lean contents of boneless pork microwave water contents in the range 30.0 – 77.0%

Water content	0	1	2	3	4	5	6	7	8	9
30	39.2	40.5	41.7	43.0	44.3	45.6	46.8	48.1	49.4	50.6
40	51.9	53.2	54.4	55.7	57.0	58.3	59.5	60.8	62.1	63.3
50	64.6	65.9	67.1	68.4	69.7	71.0	72.2	73.5	74.8	76.0
60	77.3	78.6	79.8	81.1	82.4	83.7	84.9	86.2	87.5	88.7
70	90.0	91.3	92.5	93.8	95.1	96.4	97.6	98.9		

Accuracy

The microwave test relies on the relationship between moisture and fat which, in fresh meat, is constant. For practical purposes, the relationship between fat and moisture is linear; hence the simple formula for determining CL from moisture content. The fact that moisture determination is critical to accurate CL determination has raised questions about the effect of carcass/ side chiller shrink on accuracy of both CL and the linear relationship of products of very high CL and very low CL.

Effect of Shrink

Tests were conducted under production conditions to accurately compare the CL of product from carcasses chilled overnight with product from carcasses chilled over a three-day weekend. The tests were done without any boning room pre-trim to ensure that any effect of shrink loss would be reflected in the CL test.

No significant difference was found between product chilled overnight and that chilled over a long weekend. It is clear that, under normal production conditions, the microwave CL test can be used with confidence irrespective of carcass chilling time.

Effect of Very High and Very Low CL

The formula used to define the relationship between fat and moisture is precise enough to determine CL to a commercially acceptable degree of accuracy, over a wide range of CL content. The majority of boneless meat is packed in the range 80% CL to 100% CL and a single relationship is adequate to accurately determine CL within that range.

Outside of that range the relationship does “drift” a little. The extent of the “drift” is not great; in fact, it is generally within the carton variation and sampling errors inherent in product at that CL. However, in order to keep the relationship as accurate as possible and to therefore allow for product below 80% CL, a corrected relationship has been determined for boneless beef within that low CL range.

There are therefore two relationships reported for boneless beef on page 4 and both of these were used to calculate the CL figures recorded on Table 1.

The relationship does “drift” a little above 95 CL as well but the change is of no commercial significance.

A correction should be applied to low CL boneless mutton (Table 2) or boneless pork (Table 3) and the following adjustments should be made to the product results in Tables 2 and 3:

79% CL to 65% CL: Subtract 1.5% CL from the microwave test results

Less than 65% CL: Subtract 2.0% CL from the microwave test results