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Effect of heating on free fat in comminuted meat batters

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Separation of fat and water during cooking of comminuted meat batters is determined by the migration of fat within the physical structure of the batter. The stability of the fat (resistance to migration) is determined by a number of mechanisms other than emulsification, including entrapment of fat in a protein gel matrix (Lee, 1985) and the presence of fat in intact fat cells (Oord & Visser, 1973). Tinbergen & Olsman (1979) demonstrated that selective extraction of fat from ruptured fat cells was highly correlated with the percentage of fat separation after heating. This indicates that fat cell integrity is the predominant factor determining fat migration within a comminuted batter.

In earlier work (Demeyer et al., 1974) we have used gentle hexane extraction of fat (free fat) as measure of fat cell integrity in rat adipose tissue.

In the present work, this technique was adapted as a measure of fat cell integrity and fat stability in pork adipose tissue and in meat products. It was then used on meat batters before and after heating.

Materials and Methods

Products investigated :

Samples of mayonnaise, margarine, minced meat, rendered lard and bacon lard (backfat) were obtained from local shops. Samples of Bologna type sausage (hespeworst), slicable smooth liver pâté (blokpâté) and cream liver pâté (smeerpâté) were obtained from a local factory, either as non heated batters or as finished products.

The Bologna sausage batter is obtained by cuttering pork meat, ice, salt and ingredients at temperatures below 4°C. Pork fat tissue is then added and cuttering continued at temperatures below 15°C. Slicable pâté batter is prepared in a similar way, but minced liver is added. Cream pâté however involves cuttering of fat tissue at 100°C followed by cooling, addition of additives and liver and cuttering at 40°C. (Vandendriessche, personal communication).

Analysis

Crude protein, crude fat and dry matter were analysed by official methods (Vandekerckhove & Demeyer, 1975). Myofibrillar protein was determined by extraction in high ionic strength buffer (De Ketelaere et al., 1974). Free fat as a measure of fat cell integrity was extracted with hexane from 2-3g product, placed in a folded filter paper (SS 594 A/2, diam. 150 mm) closed by stapling. The sample, wrapped in the filter is then brought into 200 ml of hexane in a 250 ml erlenmeyer, placed in a shaking waterbath (60 strokes p.m.). The hexane extract is sampled after 60 min for spectrophotometric determination of total lipid as tryglyceride, using tripalmitine as standard (Snyder & Stephens, 1959). The free fat thus extracted is expressed as % of the total fat in the sample.

Results and Discussion

Table 1 shows that the hexane extraction of free fat clearly reflects the stabilisation of fat within the fat cell membrane. More free fat is clearly extracted from products containing tissue-free non-emulsified fat (margarine, rendered lard) and emulsified fat (mayonnaise) than from fat tissue (bacon lard, minced meat). Fat in the investigated products behaves similar to fat tissue (Bologna sausage, slicable pâté) or to emulsions (cream pâté). Clearly, free fat extraction as used here reflects fat cell integrity in the former two products and the emulsion like stability in the latter. If the formation of a protein gel by heating contributes significantly to fat stability, a significant decrease in free fat content after heating of the batters can be expected.

Table 1. Free fat extracted by hexane as reflection on fat cell integrity

Product	% Crude protein[3]	% Crude Fat[3]	Free fat (% of total crude fat)[1]
Margarine	0.33	81.50	89.0^{a} ± 6.9 (9)[2]
Rendered lard	0.67	99.40	88.0^{a} ± 8.8 (5)
Mayonnaise	1.96	82.80	42.4^{b} ± 8.8 (11)
Minced meat	14.40	30.46	16.8^{c} ± 5.6 (4)
Bacon lard	1.63	89.60	15.4^{c} ± 0.1 (4)
Bologna sausage	9.20	33.90	10.2^{e} ± 1.1 (5)
Slicable pâté	13.60	19.09	7.4^{d} ± 2.0 (5)
Cream pâté	9.20	44.12	33.6^{b} ± 3.6 (5)

a, b, c, d, e Values bearing different superscripts differ significantly

1) Mean values ± SD
2) ( ) = number of determinations
3) Mean values of duplicate determinations

Table 2 shows results obtained before and after heating of the batters investigated.

Table 2. Effect of heating on free fat in comminuted meat batters

Batters	Crude Protein (2)[2] %	Crude Fat (1)[2]	Free fat : % of (1)[1]	Soluble Protein : % of (2)[1]
Bologna sausage				
non heated	8.8	17.5	8.2 ± 0.9	48.6 ± 0.1
heated[4]	9.2	39.2*	7.3 ± 1.0	18.2* ± 0.5
Slicable pâté				
non heated	-[3]	-	17.6 ± 1.6	-
heated[5]	-	-	20.2* ± 2.6	-
Cream pâté				
non heated	8.6	40.1	27.5 ± 4.0	58.6 ± 1.7
heated[4]	9.0	48.1*	35.9* ± 6.0	23.0* ± 0.9

* Significant difference with non heated batter
1) Mean values ± SD (n = 4-5)
2) Mean values of duplicate determinations
3) - = data not available
4) Batters were heated in the factory
5) Batters heated in the laboratory (72°C in 3.5 hrs)

It is clear that heating significantly lowered protein solubility but did not decrease free fat content. A significant increase of the latter was even observed for the pâtés. These findings suggest that protein gel formation by heating does not contribute to fat stability, which is mainly determined by the integrity of the fat cell. Heating may even increase the amount of free fat (pâtés in table 2) possibly by rupture of cells. More complete extraction of total crude fat after heating (table 2) may also be a reflection of the same phenomenon.

In conclusion, our results support the hypothesis that fat cell integrity rather than emulsion and/or protein gel formation is the main factor determining fat migration and thus, fat stability in comminuted meat batters, in line with earlier work (Oord & Visser, 1979).

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