8 - 19 THE EFFECT OF NON-FAT DRY MILK ON SENSORY QUALITY AND SOME PHYSICAL PROPERTIES OF COOKED SAUSAGE

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INTRODUCTION

Non-fat dry milk (NFDM) is mainly used as an extender in cooked sausage as a substitute for more expensive raw material in those countries where it is allowed. In Finland the substitution level is not restricted but for economic reasons only the cheapest meat ingredients are substituted for NFDM and so the substitution level is 3-4% in cooked sausage (Karanko 1985). NFDM also has good functional properties for the improvement the quality of cooked sausage without having an essential effect on the nutritional value. Schut and Brouwer (1975) observed that NFDM improved sausage emulsion stability. Puolanne and Ruusunen (1979) found that NFDM increased the water binding capacity and firmness of cooked sausage at low levels of addition. In practical sausage manufacture the level of NFDM in sausage is limited mostly by the fact that it produces a sweet taste and a light colour. Carpenter et al. (1977) reported no sweetness, however, in luncheon loaves with 10% NFDM and Rongey and Bratzler (1966) even with 15% NFDM in bologna. On the contrary there have been reports that NFDM improves the flavour of cooked sausage at low levels of addition (Hwang and Carpenter 1975). The aim of this study was to determine an optimal level of NFDM in a cooked sausage considering the sensory quality the most crucial factor.

MATERIALS AND METHODS

A typical Finnish frankfurter-type sausage was made for the sensory analysis. The meat ingredients were obtained from a local slaughterhouse and were stored two days at 2 °C after slaughter. 5.7 kg of beef (25% fat), 10 kg of pork (48% fat), 2.3 kg of pork fat were minced and chopped coarsely in a cutter with 6.2 l ice and water, 550 g of salt, 90 g of polyphosphate (Keitto-Sitonal, Finland) and 40 ml sodium nitrite (10% water solution). The basic mixture was divided into six parts which were processed further by substituting the mixture for 0 (control), 3, 6, 9, 12, and 15% non-fat dry milk (4% water, 1% fat, 52% lactose, 35% protein, 8% ash; Valio, Finland). Each of the six mixes was completed in a cutter with pig skin mix (14% of total batch weight; skin : water = 1 : 1), Pikant-spice mix (0.25% of total batch weight; Gewürtzmüller, FRG) and ascorbic acid (0.15% of total batch weight). Water and salt contents were equalized for every sausage mix (27.7% added water and 1.9% salt of total batch weight). The sausage mixes were stuffed into o 20-22 mm natural casings for the sensory analysis and into o 55 mm fiber casings for the objective texture measurements. Frankfurters were dried and smoked 10+25 min at 90 °C, cooked 15 min at 75 °C and cooled over night at 2 °C before they were packed in PA/PE vacuum packages. The sausage packages were stored at 2 °C until they were evaluated.

The sensory quality of sausages was evaluated within a week of packing by a panel of seven experts and a panel of 41 consumers. The panel of experts was composed of four men and three women with several years' experience in sensory evaluation of meat products. Most of the consumer panelists were middle-aged housewives. The panel of experts evaluated the frankfurters twice as cold and twice as hot (heated 4 min in a microwave owen). Six samples of frankfurters containing proportions of NFDM mentioned above were given to expert panelists in a randomized order. The experts were asked to evaluate sweetness, firmness of texture, intensity of colour and overall acceptability of cold sausages and sweetness and overall acceptability of hot sausages. Each property was evaluated on a scale anchored at both ends as follows: not sweet at all - very sweet (sweetness), very light - very intense (colour), very soft - very firm (texture), and bad - excellent (overall acceptability). Panelists evaluated the samples independently at a round table in a silent and well lit room, where fresh and tempered water was available. The panel of consumers evaluated sweetness and overall acceptability just like the panel of experts, but only of hot frankfurters (heated in water).

The graphical evaluations were scored from 1 (min) to 5 (max) and the results were tested by analysis of variance using the Dunett -test (Steel and Torrie 1980) for comparison of paired means (control by others).

The firmness of texture of the sausages was measured objectively with an Instron Universal Testing Instrument (Table Model M100) by compressing a peeled sample and by driving a metal probe into a sample to a depth of 2 cm. The influence of NFDM on the water-binding capacity of sausage was studied using a laboratory sausage method suggested by Puolanne and Ruusunen (1978). The method implies excessive amounts of added water and addition of NFDM, not substitution. The recipe of the model sausages was: 80 g of meat (beef, pork, pork fat - ratio same as above), 140 of g water, 1.9% salt and 0.3% polyphosphate. The addition levels of NFDM were 0, 3, 6, 9, 12 and 15% of the basic mix.

RESULTS AND DISCUSSION

The results of the sensory analysis were shown in Tables 1 and 2 and the flavour profile of sausage on different substitution levels is shown in Figure 1. The evaluations of the panel of experts were rather uniform, there were no significant differences ($p<0.05$) between panelists in any scores of the properties evaluated. The evaluations of experts were also in accordance with the evaluations of consumers:no significant differences ($p<0.05$) were found at any level of substitution in sweetness and overall acceptability of sausages. Both panels considered the sausages made with 6% NFDM the most acceptable (Table 2). Evaluated hot the sausages were significantly (experts $p<0.05$ and consumers $p<0.01$)) better with 6% NFDM than controls (without NFDM). On the other hand there was no difference between the controls and the sausages with the highest substitution level. When evaluated cold the overall acceptability did not get worse ($p<0.05$) until 15% meat base ingredients were substituted for NFDM (Table 1). Also Carpenter et al. (1977) reported no significant difference in the flavour of luncheon loaves with 10% NFDM which were assessed cold.

It was found that the sweetness of sausages increased when the proportion of NFDM increased, but the difference of sweetness to the controls was perceived more sensitively at a lower level of substitution in hot sausages than in cold sausages (Tables 1 and 2). The panel of experts evaluated the colour of sausages as being lighter when the substitution level was 9% or more (Table 1). This was in accordance with Rongey and Bratzler (1966) who stated that bologna produced with 10% NFDM was slightly lighter in colour than with control formulas. Carpenter et al. (1977) couldn't find lighter colour in luncheon loaves with 10% of NFDM than 0 or 5% of NFDM. NFDM was not observed to have an essential effect on firmness either sensorially (Table 1) or physically (Table 3). The water binding capacity of sausage increased sharply up to the 3% level of addition (the meat proportion was constant) and very slightly at higher levels of addition (Table 3) which was analogous with the experiments of Puolanne and Ruusunen (1979). It is not fully clear if the increase in water binding arises only from rehydration of NFDM or additionally from the fat stabilizing effect of milk protein reported by Schut and Brouwer (1975).

It can be concluded that sweetness was the dominating factor decreasing the acceptability of sausages when meat ingredients were substitued for 9% or more NFDM. The improvement of acceptability from 0% to the optimal 6% of NFDM could not be expounded by any of the variables alone. Interaction of the variables sweetness, colour, and firmness or off-flavour masking could be possible explanations, but it has also been reported that NFDM lactose or maltol (results when lactose is heated) has the capacity to accentuate flavours (Jennes and Patton 1959, Nickerson 1978, Oberdieck 1981). On the sensory quality optimal level (6% NFDM) the sausages could be manufactured with 2.2% lower raw material costs. In recipes with marginal meat protein content NFDM may have a beneficial stabilizing effect.

It is worth noticing that the results should not be applied to cooked sausage in general because sensory quality is a result of a great number of variables like composition of raw material, additives, spicing or manufacturing process details.

Table 1. The evaluations of a panel of experts on the sweetness, colour, firmness and overall acceptability of cooked sausage when meat ingredients were substituted for 0, 3, 6, 9, 12, and 15% NFDM. Mean scores of 14 evaluations of cold sausages (min = 1, max = 5).

substitution level (%)	sweetness	colour	firmness	overall acceptability
0 (control)	2.4	3.2	3.0	3.2
3	2.4	3.4	3.1	3.5
6	2.7	3.7	3.5	3.5
9	3.3	2.2**	3.4	3.0
12	3.9*	2.8	3.4	2.8
15	4.8**	2.4**	3.1	1.9**

* In each column indicates a significant difference ($p<0.05$) compared with the control level.
** In each column indicates a significant difference ($p<0.01$) compared with the control level.

Table 2. The evaluations of a panel of experts on the sweetness and overall acceptability of cooked sausage when meat ingredients were substituted for 0, 3, 6, 9, 12, and 15% NFDM. Mean scores of 14 (experts) and 41 (consumers) evaluations of hot sausages (min = 1, max = 5).

substitution level (%)	sweetness		overall acceptability	
	experts	consumers	experts	consumers
0	1.9	2.0	2.5	2.9
3	2.3	2.5	3.0	3.4*
6	2.8	2.7**	3.5*	3.7**
9	2.9*	3.0**	3.4	3.0
12	4.1*	3.6**	2.3	2.7
15	4.3*	4.1**	2.1	2.6

* In each column indicates a significant difference ($p<0.05$) compared with the control level.
** In each column indicates a significant difference ($p<0.01$) compared with the control level.

Table 3. Objective measurements of water binding capacity (WBC) and texture on different levels of NFDM in cooked sausage. Means of three replicates. For experiment arrangements see text.

level of NGDM	WBC (g water/100 g lean meat)	breaking strength (kg)	compression strength (kg)
0	52.1	5.4	4.4
3	105.2**	4.9	5.7
6	119.6**	5.1	4.9
9	123.2**	4.2	4.3
12	129.4**	4.1	5.1
15	136.1**	3.5	4.9

* In each column indicates a significant difference ($p<0.05$) compared with the control level.
** In each column indicates a significant difference ($p<0.01$) compared with the control level.

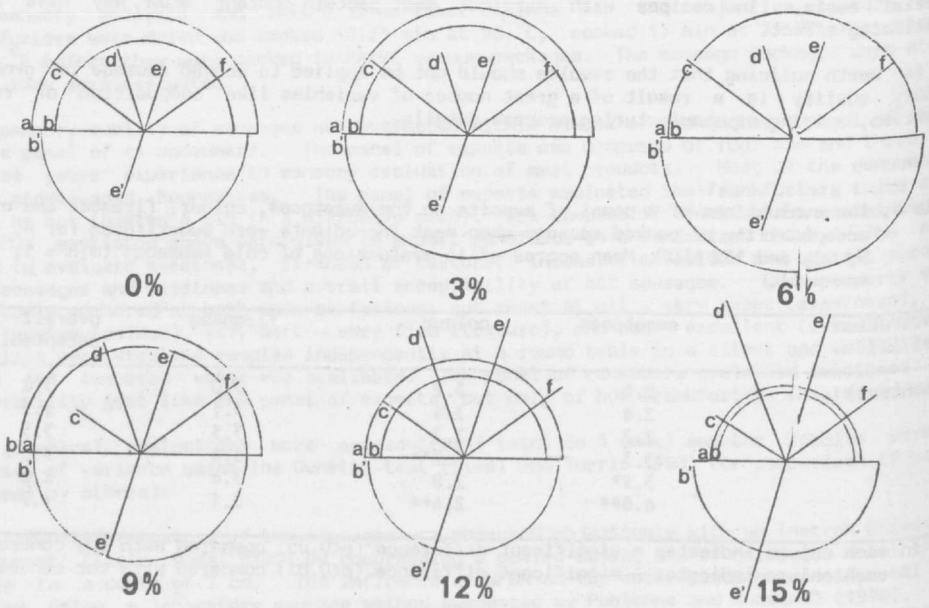

Figure 1. Flavour profile of a cooked sausage with different substitution levels of NFDM (0, 3, 6, 9, 12, and 15%). Evaluations of a panel of experts: overall acceptability of (a) cold and (b) hot sausages, (c) colour of cold sausages, sweetness of (d) cold and (e) hot sausages and (f) firmness of cold sausages. Evaluations of a panel of consumers : (b') overall acceptability and (e') sweetness of hot sausages.

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