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Processing of cooked sausages containing unsaturated vegetable oils.

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SUMMARY: Finely comminuted cooked sausages with pork or beef, water, spices, ascorbate and 1.6 % salts were manufactured which contained either 25 % of back fat or olive oil or sunflower oil. For the production of cooked sausages containing unsaturated vegetable oils the following hints can be given: 1) After a short time of comminution with the bowl chopper (between about 0 to 8 °C), the oil containing batters seem to be unstable. They stabilize visibly during an extended comminution. 2) After knowing the fatty acid profile of the different fat-phases (fats and/or oils) it is possible to "tailor" the fatty acid composition of the lipids of cooked sausages. 3) On eating oil containing cooked sausages, no oily or greasy mouth-feel develops. Oil containing cooked sausages of a bigger calibre (kal. 60 mm) induce a crumbly mouth-feel on eating. 4) After the addition of oils the cuts of cooked sausages are lighter and less red in colour than after the addition of fat pork. If the colour of the sausage-cuts is of importance, then beef instead of pork should be taken for the production of cooked sausages with unsaturated vegetable oils.

INTRODUCTION: With respect to the health-value of the diet, among others the addition of salts, additives and of fats of animal origin to meat products is discussed. In order to minimize the occurrence of a coronary heart disease, the diets should contain no more than about 30 % of their calories as fat. Saturated plus polyunsaturated fats should not amount to more than 20 % of the total caloric intake (GRUNDY et al., 1982). The fatty acid composition of the tissues of monogastric animals can be influenced by the kind of fat in their fodder (FISCHER et al., 1990). The possibility to lower the amount of saturated fats and to increase the amounts of unsaturated fatty acids in tissues of the pig was examined (RHEE et al., 1990 a; RHEE et al., 1990 b; SHACKELFORD et al., 1990 a). Finely comminuted cooked sausages with 20 and 25 % fat meats from pigs fed a fodder high in oleic acid were not heat stable (SHACKELFORD et al., 1990 b). For the production of cooked sausages it seems however to be a detour to utilize tissues from specially fed animals. A simple way to inrease the amounts of unsaturated fatty acids and to decrease the amounts of saturated fatty acids of cooked sausages is to add unsaturated vegetable oils instead of fat pork to batters.

From published results about the possibility to incorporate unsaturated vegetable oils into a cooked sausage batter, no unequivocal conclusions can be drawn. With respect to the heating loss of batters with fat pork, sunflower oil or fish oil, no differences existed (PARK et al., 1989). In other investigations decreased heating losses resulted from the addition of increased amounts of unsaturated fats to the batters (ST.JOHN et al., 1986), and the amount of fat and water separation increased, when higher unsaturated instead of less unsaturated fats were utilized (WHITING, 1987). Cooked sausage batters showed a higher cooking loss and a bad texture on eating after the addition of castor oil instead of fat pork (TOWNSEND et al., 1971). There exists the opinion, batters with plant oil would only be heat stable, if the oils were first emulsified with caseinate before they are added to the rest of the raw materials, or that it is absolutely necessary to add emulsifiers or phosphate to the oil containing batter (FREY, 1974). Therefore the question arises, if with commercial equipment, and under commercial conditions of the sausage making process, heat stable cooked sausages containing unsaturated vegetable oils can be manufactured.

MATERIAL and METHODS: Because the salt uptake of Europeans and Americans is too high, an amount of NaCl should be added to cooked sausages which is not higher than technologically necessary. With 1.6 % of NaCl cooked sausage batters of normal composition (no more than 30 to 35 % of fat, about 60 % of water) are heat stable, and for the German consumers the salt taste is not too low (WIRTH, 1988). The amount of tissues from animal origin in sausages must be higher than 50 %. Therefore the meat content (pork or beef) of the sausages had to be 51 %. Lean beef containing batches will be referred to

the following as beef batches, those containing lean pork as pork batches irrespective of the utulization of fat pork or oils. Because the aim of the project was not to produce sausages of a low coloric value, but to produce good tasting cooked sausages with high amounts of unsaturated fatty acids, 25 % of pork fat or oilve oil or sunflower oil was added. To acchieve a good cured colour ascorbate was added as a reducing agent. 0.04 % of ascorbate are enough for this purpose. The rest of the recipe had to sum up to 100 %, so the amount of water was 21.76 %. Table 1 shows the recipe. The meats were preground through the 3 mm plate of a grinder. Meats and oils were stored over night at ± 0°C before the cooked sausage batter was comminuted. The batter production took place under vacuum in a 60-liters vacuum chopper. Lean meats, ice, salts and spices were chopped to about 1 °C, then the fat pork or the oils were added and the comminution was continued to a temperature of about 12 °C. Batters with fat pork were then removed from the chopper, filled in casings and heated. From the oil containing batters one part was removed at 12 °C chopping-temperature, and the comminution was continued to 18 and 22 °C. At 18 °C a second part of the batter was removed from the cutter, and at 22 °C the rest was taken out of the shopping-bowl. So each batch of the oil containing cooked sausage batters consisted of three parts with temperatures of 12, 18, and 22 °C respectively. After a short time of comminution, the oil containing batters seemed to fall apart in the chopper. The typical "bind" developed however in every case, when the comminution was continued to temperatures of about 8 to 10 °C. Wieners (natural casing, cal. 24/26 mm, length about 15 cm), were smoked and cooked to a core temperature of about 70 °C. One part of the wieners was after that put together with brine into cans and autoclaved to a F_c-value of 4. Bolognas (impermeable artificial casing, cal. 60 mm, weight about 800 g) were cooked to a temperature of about 70 °C, and batters in cans (200 ± 1 g) were autoclaved to a F_c-value of 4. The weight loss of wieners, heated to 70 °C, that of wiener-preserves and the amount of water separation of the autoclaved batters were determined. Both types of wieners and the bolognas were examined for their lightness (L*-value), their redness (a*-value) according to STIEBING and KLETTNER (1980) and their breaking strength (Newton (N), first peak with the Instron 1140). The breaking strength is closely and positively correlated with the percieved bite of a cooked sausage (KLETTNER, 1988). Wieners and bolognas were analysed sensorically for their texture and taste. The differences in the mean values of lightness, colour and breaking strength were examined by the Tukey-test (WEBER, 1980). Those differences are statistically significant, which are larger than the amounts indicated below the mean values in table 2. All experiments were repeated three times.

Table 1: Recipe of cooked sausages with animal fat or vegetable oils

pork or beef (lean, from the shoulder)	51.00 %
back fat or olive oil or sunflower oil	25.00 %
ice	21.76 %
nitrite curing salt (99.5 - 99.6 % NaCl, rest $NaNO_2$)	1.60 %
spices	0.60 %
ascorbate	0.04 %

RESULTS and DISCUSSION: The amount of weight- and water-losses of the different products was independent of the used oil (olive oil or sunflower oil) and did not depend upon the intensity of comminution of the oil containing batters. The loss of mildly heated wieners was in addition to that not influenced by the kind of meat (pork or beef) or the fat-phase (fat pork or oils). Their weight-losses were between 9 and 10 % (table 2).

Wiener preserves with animal fat and lean pork or beef showed fat separation. The weight-losses of these preserves were not different and between 7 to 11 %. Oil containing wiener-preserves showed higher losses of about 13 to 17 % (table 2). The lower weight losses of preserves with fat can be explained. In the moment, the fat separated from the heat coagulated and rigid protein gel, the surrounding brine, which has a higher specific gravity, was incorporated into to cavities.

Pork batches with fat pork had a significantly better water holding capacity than beef batches with pork fat. Oil containing batches with beef (16 to 20 % water separation) were less heat stable than oil containing batches with pork (7 to 9 % water separation). The reason for that is probably the higher pH-value of the pork. The arithmetic mean of the pH-values of the lean

pork was 5.9, that of lean beef was 5.7 (not shown in a tabular form). The exchange of fat against unsaturated vegetable oils did not result in a higher water separation. On the contrary, with beef-batters it resulted in an improvement of the water-binding by a factor of 1.3 to 1.5. A separation as high as that of beef batches with fat pork had only beef batches with olive oil after a comminution to 22 °C. With pork batches only one treatment resulted in a variable water-separation. After chopping oil containing batters to 22 °C, the preserves showed a lower water separation than the batches with fat pork.

Table 2. Water binding, breaking strength, lightness and redness of the products.

batch			property of the product *) 1	2	3	4	5	6	7	8
pork and	back fat,	12 °C	9.1	7.4	13.3	10.7	16.1	10.8	72.8	15.6
pork and	olive oil,	12 °C	9.8	13.8	8.3	14.8	19.2	10.0	79.8	11.7
"	"	18 °C	10.1	13.1	8.0	14.9	20.7	12.1	81.3	10.8
"	"	22 °C	10.5	12.9	6.7	14.5	18.6	11.7	81.7	10.7
pork and	sunflower oil,	12 °C	9.2	14.2	9.3	14.6	22.0	11.2	80.7	11.7
"	"	18 °C	9.4	16.4	8.1	15.6	23.4	13.0	82.2	10.9
"	"	22 °C	9.7	16.7	7.7	14.4	20.1	12.0	82.5	10.7
beef and	back fat,	12 °C	10.7	11.3	25.3	17.2	27.2	26.0	64.5	21.0
beef and	olive oil,	12 °C	9.7	12.8	18.9	16.8	21.6	21.6	71.8	17.2
"	"	18 °C	10.1	13.5	18.4	16.4	22.1	22.0	74.1	16.1
"	"	22 °C	9.8	14.7	20.3	14.2	21.5	19.9	74.7	15.8
beef and	sunflower oil,	12 °C	9.3	15.3	16.5	16.6	24.6	17.8	72.6	17.3
"	"	18 °C	9.9	16.2	18.0	16.8	24.6	19.2	75.1	15.9
"	"	22 °C	10.3	16.6	18.9	14.0	20.9	19.0	75.8	15.5
Two batches are significantly different ($\alpha \leq 0.05$), if their values differ by more than the following amount:			3.1	4.7	5.4	5.6	10.9	7.2	2.8	1.3

) property of the product: 1: cooking loss of wieners (%), 2: total loss of wiener-preserves (%), 3: water separation of batter-preserves (%), 4: breaking strength of bologna (N), 5: breaking strength of wieners (N), 6: breaking strength of wiener-preserves (N), 7: lightness (L-value) of bologna, 8: redness (a*-value) of bologna.

Regarding differences in lightness and redness, those of cooked sausages, which are cut before they are sold, are important. Therefore table 2 contains only results for lightness and colour of sausages of cal. 60 mm. After a comparable intensity of comminution (12 or 18 or 22 °C), no differences existed between pork sausages with olive- and sunflower oil. The same was true for beef sausages. A varied intensity of the batter-comminution did not influence the lightness or colour of pork sausages with oils. Sausages with beef and oils exhibited a larger L*-value and a lower a*-value after a batter-comminution to 22 °C than after a batter-comminution to only 12 °C. Pork sausages with fat pork were in lightness and redness comparable to beef sausages with olive- or sunflower oil (table 2).

The breaking strength of wieners and bolognas was neither influenced by the kind of the fat-phase (fat pork, olive- or sunflower oil) nor by the chopping-intensity of the batters (table 2). Beef-wiener preserves with sunflower oil were after a short comminution to only 12 °C softer than beef-wiener preserves with fat pork.

Cooked sausages with oils had a good bind on eating and were less moist than cooked sausages with fat pork. In no case the oil containing sausages gave rise to a oily or fatty mouth feel. Oil containing bolognas fell apart more crumbly on eating than fat pork containing bolognas. Olive oil gave the sausages its typical flavor. With the same amount of spices, cooked sausages with oils tasted less spicy than cooked sausages with fat pork.

The current explanations for a fat separation of cooked sausage batters on heating rest, besides on influences exerted by myofibrillar proteins, basically on three associated conceptions. One is, that the behavior of the fat-phase within a batter can be explained, if the batter is regarded as an emulsion (TAUBER, 1957). The second is, that the amount of fatty tissue of animal origin, which can be added to a cooked sausage batter before fat separation occurs on heating, depends on the amount of free fat, which is not enclosed in fat cells (TINBERGEN and OLSMAN, 1979; VAN DEN OORD and VISSER, 1973). According to the third conception, fats or oils are not uniformly dispersible in the batter, if they are fluid (LEE, 1985). Fluid fats or oils possess a high mobility, they flow together and by that they destabilize the batter (LEE, 1981). According to the results of this project, the

general validity of these conceptions must be questionable. At batter temperatures between about 12 and 22 °C the 25 % of unsaturated oils were not enclosed in cells, and they were liquid. But they did not destabilize the batters. An increased dispersion of the oils, brought about by a prolonged chopping, overchopping to 22 °C, did not exhaust the coating-ability of the meat proteins.

CONCLUSIONS: It is technologically possible, to replace fatty tissue of animal origin in the recipe of a cooked sausage by unsaturated vegetable oils, and no massive fat- and/or water separation must occur. The fact, that within a sausage batter free and liquid oil is present, does not necessarily lead to an instability of the batter on heating. To find generally acceptable reasons for the instability of overchopped cooked sausage batters with fatty tissues from animals (temperatures higher than 12 to 15 °C) further investigations are necessary.

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