QUALITY CHARACTERISTICS OF SAUSAGES MADE FROM MUSCLES ORIGINATING FROM DIFFERENT FIBRE TYPES

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Background: Several papers during the last decade report on the functional differences between myosins and myofibrils originating from different fibre types. Such differences are found in gelation, solubility, solubilization and extractability (Samejima et al., 1986). Also in intact meat there are documented differences in colour and texture (Lawrie, 1985). In this work we have used muscles of defined fibre type composition and studied what is the most important sensory attributes for sausages made from different fibre type compositions. The approach differs from previous attempts as specific muscle types were used in the sausage production. Extreme care was executed to dissect all visible fat and connective tissue from the muscle samples prior to sausage production in order to emphasize the role of muscle.

MATERIALS AND METHODS

Meat samples: Six muscles, i.e *Masseter* (M), *Infraspinatus* (IS), *Semispinalus capitis* (SC), *Supraspinatus* (SP), *Lattissimus dorsi* (LD) and *Cutaneus trunci* (CT) from Norwegian Red Cattle were used. The fibre type compositions were: *Masseter* (100 % type I), *Infraspinatus* (79 % type I and 15 % type II B), *Semispinalus capitis* (60 % type I and 16 % type II B), *Supraspinatus* (42 % type I and 25 % type II B), *Lattissimus dorsi* (15 % type I and 55 % type II B) and *Cutaneus trunci* (8 % type I and 72 % type II B), the remaining percentages being of type II A. Three different cooling rates were used (Fig 1). All muscles were trimmed free of fat and connective tissue and ground before myofibril isolation and sausages production.

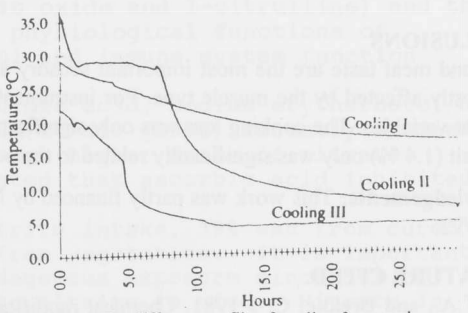

Fig.1 The different profile of cooling for muscles

Sausage production: Muscles were ground through a 13 mm plate and the protein content determined. Meat to standardise protein content, was weighed 1 day *post-mortem*, presalted with low salt (1.4 %) and high salt (2.0 %) and stored in cold room at 3.5°C until next day's sausage production. Sausages were were formulated as 10 % meat protein, 17 % pork fat, spice mix (0.3 %), potato flour (5 %), dried skimmed milk powder (3 %) and sodium ascorbate (0.3 %). The meats and ingredients were mixed and chopped using a six blade bowel cutter for 5 minutes. Amount of ice water added (19-25 %) depended on meat weighed. End chopping temperature ranged between 14°C and 15.5°C. Batters were removed from the chopper, vacuum stuffed into natural (sheep) casings and smoked. The temperature attained after smoking was 72-75°C. Cooking losses(%) was determined by weighing. Sausages were vacuum packaged and stored at -40°C for subsequent analyses. Two productions (exp. 1 and exp. 2) were carried out; exp 1 had muscle type, salt, day and cooling rate as design variables while exp. 2 had cooling rate and muscle as design variables.

Sensory analysis: A trained 10- member panel evaluated the sausages quality in duplicate using a descriptive test (ISO, 6564-1985 E). Sausages were served hot. Sixteen attributes were profiled using a a continous non- structured scale (1-9). Data were registered on a computerised system (Compusence, Ontario, Canada).

Texture analysis: Cooked sausages were measured, ten replicates, with a Texture Analyser TA. XT2 (Stable Micro System) operating in compression mode. Samples, 25 mm in diameter and 15 mm height were axially compressed to 75 % of their original height using a flat cylindrical disk (50 mm diameter) driven at 0.8 mm/sec. The maximum peak force (N) was used (hardness).

Myofibrillar extractability: Myofibril preparation was carried out essentially according to Eisele and Brekke (1981). Myofibrillar protein extractability of *Masseter* and *Cutaneus trunci* was studied for cooling I and cooling III (Fig 1). The extractability of myofibril proteins was determined by suspending the myofibril suspensions in 0.6 M NaCl at pH 5.7. The protein concentration in the supernatants was determined by the Biuret method following centrifugation at 28000 x g for 1 hr.

Data analysis: Analysis of variance (ANOVA) for all data was run using the General Linear Model procedure (SAS Institute, 1985). Regression analyses were carried out by using Minitab statistical soft ware version 9.2 (Minitab Inc, 1993). The main trends of variation among sausages were studied by the principal component analysis (PCA) using UNSCRAMBLER extended version 5.5 (Camo, AS, Trondheim, Norway).

RESULTS AND DISCUSSION

Sensory analysis: Many of the 16 sensory attributes were highly correlated (Fig. 2) for both experiment 1 and 2, and therefore only some attributes were discussed here. The major source of variation, 60 % (PC1), was largely associated with colour and meat taste. Factor 2 (PC2) was largely associated with hardness, elasticity and fatty feeling. Factor 3 (PC3) was associated with salt taste. Juiciness was linked to both PC1 and PC2. Colour strength and meat taste were negatively correlated (Fig. 2), and both attributes highly correlated to the percentage of type II B fibre (r = 0.9-0.99). *Cutaneus trunci* sausages, highest in II B fibers, had the lowest colour, elasticity and

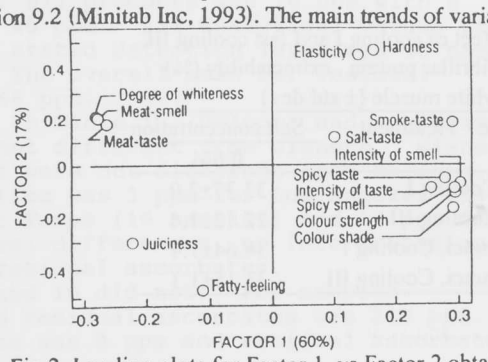

Fig.2 Loading plots for Factor 1 vs Factor 2 obtained by PCA for sensory attributes of sausages

fatty feeling/juiciness were negatively correlated. The PCA bi-plot (Fig. 3) shows that hardness was highest for the sausages of the mixed fibre muscles (*Infraspinatus, Semispinalus capitis* and *Supraspinatus*). Fig.3 showed that sausages had a tendency to be classified into three groups. The first group was composed of *Masseter* (red) sausages and placed on the extreme right of the bi-plot. The second group was composed of the sausages made from mixed muscles i.e *Supraspinatus Semispinalus capitis* and *Infraspinatus.*They were placed on the right upper side of the bi-plot and the central part of the plot. The third group consisted of sausages made from white muscles i.e *Cutaneus trunci* and *Lattissimus dorsi.* The most important source of variation for the sensory attributes was the muscle type. The muscle-salt interaction was also important for meat taste, hardness and juiciness. Thus the effect of salt on hardness, colour and juiciness depended on the muscle type. When the salt was not a design variable, the muscle-cool interaction was important for meat taste, hardness and juiciness.

Texture measurements: Table 1 shows the analysis of variance for the parameter hardness. The major source of variation was the type of muscle, interactions thereof and the salt level and cooling. In particular it should be noted that the effect of cooling depended on the type of muscle used. Results could be divided into two groups; high salt and low salt sausages. A significant linear relationship ($r = 0.84$) between type IIB fibers and hardness was found for the sausages containing 1.4 % salt, while this was not the case for sausages containing 2 % salt. This observation might also explain why the correlation between sensory hardness and fiber type IIB was low when the salt level was a design variable. Increasing the salt level induced nonlinearity in the relationship between fiber type and hardness.

Cooking loss: The variation in sausage's cooking loss with different cooling rates is shown in Figure 4. Cooling II resulted into lowest cooking loss. Cooling I resulted into moderate and cooling III resulted into the highest cooking loss at average. If only low salt sausages of cooling I and III were compared (Table 2), a significant effect of cooling rate was noted. Fig. 4 also lends support to the analysis of hardness that interactions between muscle and cooling are present.

Myofibrillar extractability: The effect of cooling on the protein extractability of red and white muscles is shown (Table 3) The *Masseter* myofibrils (cooling I) showed greater protein extractability than *Masseter* myofibrils (cooling III). However, such differences were not observed for Cutaneus trunci myofibrils under same conditions. Measurements of myofibrillar extractability (Table 3) confirmed that *Masseter(type I)* was more affected by cooling than was *Cutaneus trunci (type IIB)* as also indicated in Fig .4.

CONCLUSIONS

Colour and meat taste are the most important sensory attributes with respect to describing the variation of sausages. These attributes were mostly affected by the muscle type. For instrumentally measured hardness the muscle type, cooling and salt level were the most important variables. The cooking loss was only significantly related to cooling rates. Colour strength, meat taste and hardness, the later at low salt (1.4 %) only was significantly related to the percentage of type IIB, using simple linear regression.

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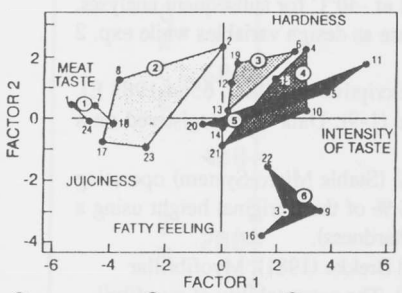

① Cutaneus trunci, ② Lattissimus dorsi, ③ Suspraspinatus
④ Semispinalus capitis, ⑤ Infraspinatus, ⑥ Masseter

Fig.3 PCA bi-plot on sensory attributes of sausages

Table 1. Effect of muscle type, cooling, salt, storage time(day) and their interactions on hardness of sausages (exp. 1and 2, 36 samples)

Factor	Variance explained (%)	P-Value
Muscle	46.23	0.002
Cool	0.48	0.435
Day	3.58	0.760
Salt	8.97	0.003
Muscle*cool	27.1	0.020
Muscle*salt	12.14	0.019
Error	1.48	

Table 2. Effect of muscle type, cooling, salt, storage period (day) and their interactions on cooking losses of sausages. (Cooling I and III, 1.4% salt, 24 samples)

Factor	Variance explained (%)	P-Value
Muscle	3.55	0.9199
Cool	37.24	0.0072
Day	11.17	0.0570
Cool*Day	11.64	0.0526
Error	36.39	

Table 3. Effect of cooling I and fast cooling III on the myofibrillar protein extractability (%) of red and white muscle (± std dev)

Muscle type / Treatment conditions	Salt concentration 0.6M
Masseter, Cooling I	33.37±2.0
Masseter, Cooling III	22.12±1.4
Cutaneus trunci, Cooling I	34.64±1.4
Cutaneus trunci, Cooling III	33.15±1.3

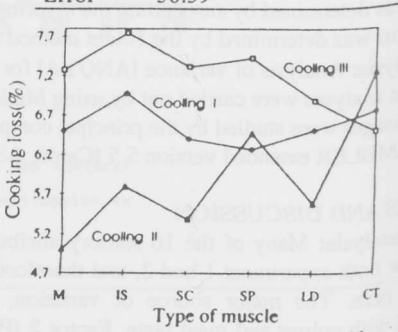

Fig.4 Relationship between cooking loss (%) and type of muscle for different cooling rates.