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INFLUENCE OF NON-MEAT PROTEINS ON THE COLOUR OF COOKED MEAT BATTER

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Background

Apart from their beneficial effects on many functional properties (1) the abundance of non-meat proteins and their wide application in a complex meat batter may have a risk of colour deterioration, which may be attributed to the decreased haem pigment content and lower level of reducing capacity when meat component has been partially replaced (2); inherent colour of non meat protein; the reduced colour formation due to elevated pH (3); change of gel microstructure in the presence of non-meat protein.

Objectives

The present study aimed at assessing the magnitude of change in pH, cured muscle pigment and chromatic coordinates in a model system containing sodium pyrophosphate, which represents the fat free fraction of meat batter as influenced by the nature and the level of non-meat proteins.

Methods

Model system was formulated to contain 12.5 % protein, 2.5 % NaCl and 0.125 % or 0.375 % $Na_4P_2O_7$ (SPP). Assuming 20 % fat content of sausage batter, this formula corresponded to 0.1 or 0.3 % SPP calculated to a fat completed batter.
Three commercial package containing 20 kg of plastic covered deboned chilled pork shoulder was sampled: appr. 300 g meat representing muscles of pork shoulder were removed from each package. Drip fluid was also taken and frozen at -20 °C. Meat samples was finely comminuted by Moulinex mincer then frozen at -20 °C until using within 5 days. Commercial preparations of four groups of non-meat proteins (NMP) of different basis (blood plasma, collagen, soy and milk) were used for either total or partial replacement of meat protein (100, 40 or 30 % NMP): powdered blood plasma (BP), powdered rind (PR), isolated soy protein (SI), soy concentrate (SC), soy flour (SF), caseinate (MI), milk proteins (MC1, MC2). In addition, hot minced pork rind (PR) and minced chicken skin were examined. Protein content of meat and NMP-preparations as well as myoglobin content of meat and fluid samples were determined (4, 5). To avoid colour change associated with the reduction or the lack of muscle pigment added drip fluid was used to even out the variation of myoglobin content: 2.0 mg myoglobin/g wet weigh was applied in each case. At 60 min after mixing of ingredients in glass tubes of 2.5 cm diameter cooking was performed at 75 °C for 45 min. After cooling to 20 °C and a further 3 days of refrigeration the colour was determined on the centre of fresh cut surface with a Minolta Chromameter CR-300 (CIE L*a*b*), when D_{65} illumination was applied. The pH of raw meat, as well as of uncooked and cooked models were measured by DeltaTRAK pH meter equipped with combined ISFET electrode. Using the central part of the cooked sample conversion of nitrosyl-myoglobin (%) was determined (5, 6).

Results and discussions

Table 1. shows means and pH differences between uncooked and cooked model of different protein source for two levels of SPP as well as between models containing 0.3 and 0.1 % SPP for uncooked and cooked model. Generally, an increase of pH after cooking was obtained. Control pure meat system showed much higher increase pH (0.2 unit) after cooking as compared to pure NMP-products (0.04-0.11 unit). This may suggest more structural change during heating involving interaction with charged groups of muscle proteins in combination with the inherent ionic milieu of muscle tissue and added ionic ingredients. The higher level of SPP caused a higher pH (appr. 0.2 pH unit in average) both in cooked and uncooked models with extreme values of blood plasma and collagen-based proteins 0.24-0.32 pH unit and 0.12 pH unit of milk- based group, respectively. Higher level of SPP reduced the colour development e. g. the rate of nitrosyl haem conversion by 8.2 % in average. Nitrosyl haem conversion determined in cooked models correlated significantly with pH of uncooked model ($r=-0.85$ $P<0.001$)) and also with pH of cooked model ($r=-0.68$ $P<0.01$), when higher level of SPP was applied. In the case of lower content of SPP no significant correlation was obtained.
When 30 % of meat protein (meat-6,3 pH sample) was replaced with a series of NMP, the pH of cooked models containing 0.3 % SPP tended to be shifted according to the pH of pure NMP models (pH 5.9-7.3) (Fig. 1.) The colour hue of pure models ranging from yellowish (high value of b*/a*) to pink (low value of b*/a*) appeared to be expressed in the models containing 30 % NMP (Fig. 2). In the presence of caseinate (MI) and to a lesser extent of isolated soy protein (SI) and milk concentrate (MC1) the pink colour of cured pigment was clearly expressed; whereas collagen-based ingredients showed rather fade, yellowish colour. Even an increase of 30 % NMP replacement to 40 % resulted in detectable shift of chromatic parameter b*/a* (40-30 % NMP), which is positively related to the difference obtained for pH (40-30 % NMP) (Fig. 3) and inversely to the difference for nitrosyl-haem conversion ≈ NO-hem %(40-30 %NMP) (Fig. 4). In the Fig. 3 and 4 data are located along two parallel lines, the upper one corresponds to those NMP preparates, which have an inherent yellowish hue, while the lower one includes MI, SI and MC1 having no inherent colour. It can be concluded from Fig. 3 and 4 that the hue difference associated with incorporation of NMP may originate from the variation of cured pigment formation and also from the inherent colour of a given NMP.

Conclusion

Depending on the pH difference in cooked meat/non-meat protein model system, non-meat proteins may change of colour hue in association with nitrosyl-haem formation. Inherent colour of NMP, if any, can also contribute to the colour of cooked meat model.

References

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Table 1: Effect of non meat protein on the pH and nitrosyl haem conversion of model system

Protein type	number of pure preparates	pH uncooked 0.3 % SPP	pH cooked 0.3% SPP	pH uncooked 0.1 % SPP	pH cooked 0.1 % SPP	ΔpH (cooked-uncooked) 0.3 % SPP	ΔpH (cooked-uncooked) 0.1 % SPP	ΔpH (0.3-0.1 % SPP) uncooked	ΔpH (0.3-0.1 % SPP) cooked
Blood plasma [a]	1	6.54	6.66	6.28	6.34	+0.12	+0.06	+0.26	+0,32
Collagen [b]	3	6.74±0,4	6.85±0,3	6.50±0,6	6.60±0,5	+0.11	+0.10	+0.24	+0.25
Soy [c]	4	6.26±0,3	6.37±0,3	6.10±0,2	6.20±0,2	+0.11	+0.10	+0.16	+0.17
Milk [d]	3	6.18±0,3	6.23±0,3	6.06±0,2	6.10±0,3	+0.05	+0.04	+0.12	+0.13
Meat [e]	3	6.15±0,2	6.36±0,2	5.96±0,25	6.17±0,15	+0.21	+0.21	+0.19	+0.19
Overall	14	6.36±0,35	6.47±0,35	6.18±0,35	6.28±0,32	+0.11	+0.10	+0.18	+0.19
Nitrosyl haem %	14		44.8±23		53.0±23				
Correlation (pH vs. Nitrosyl hem %)		-0.85 (P<0,001)	-0.67 (P<0,01)	-0.48 NS	-0.47 NS				

[a] powdered beef plasma; [b] powdered pork rind; hot minced pork rind gel; skin of chicken; [c] isolated; concentrated; flour-1; flour-2; [d] sodium caseinate; concentrate-1; concentrate-2; [e] meat-pH 6.3; meat 5.9; meat-pH 5.8 (ultimate pH).

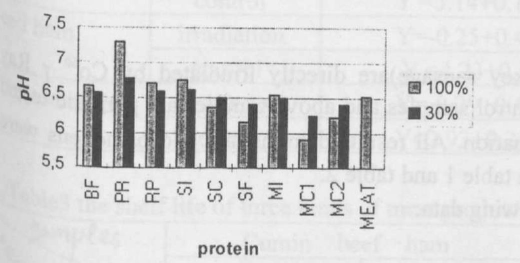

Fig. 1- Effect of non-meat proteins on the pH of model batter (replacement of meat protein by 30 and 100%)

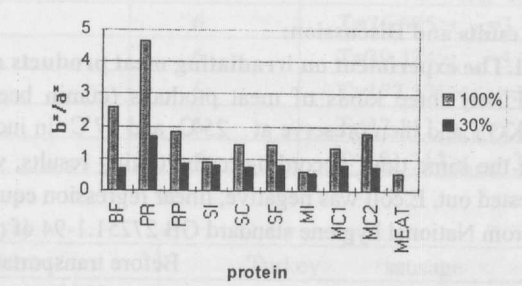

Fig. 1- Effect of non-meat proteins on the colour hue index (b*/a*) of model batter (replacement of meat protein by 30 and 100%)

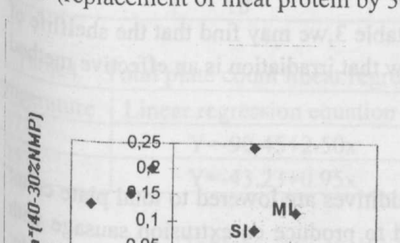

Fig. 3- Effects of increasing meat protein replacement from 30 to 40% on the pH and the colour hue index (b*/a*) in model batter

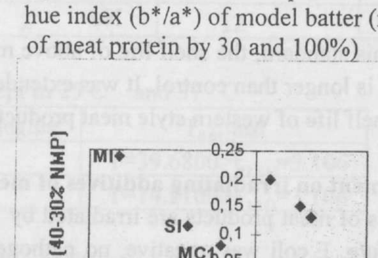

Fig. 4- Effects of increasing meat protein replacement from 30 to 40% on the nitrosyl-hem conversion% and the colour hue index (b*/a*) in model batter