NEW HEALTHY MEAT PRODUCTS CONTAINING VEGETABLES

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The aim of this study was to develop new healthy meat products that can create a new market platform, for example a new meat snack product. Two new healthy meat spreads consisting of 40% pork and 40-50% butternut and carrot or green pea and split pea were developed. The products can, for example, be used as a dip for snacks or as a sandwich spread. The products had a very low fat content between 0.7-3.8%, a low salt level (1.1%) and a protein content between 11.3-14.8%. The products were produced by chopping pork filet, vegetables and seasoning and mixing them to a smooth texture. The products were either pasteurised/vacuum-packed or preserved by addition of 1% sodium lactate and MA-packed. The MA-packed product had a shelf-life between 7-21 days, and the pasteurised product a shelf-life of at least 28 days. A sensory test showed a significant increase in sour taste in the pea product after 21 days' storage at 5°C, whereas few changes were observed in the butternut products. A consumer test showed that pea spread was the most preferred product. For consumption, most consumers chose dip (54%) or sandwich spread (46%) as the best use for the spreads.

Key words: Meat spread, meat snack product

I. INTRODUCTION

In developed countries, there is increasing consumer interest in healthier foods with natural ingredients and low fat and salt contents, and this also applies to meat products. Consumers are becoming more aware of the environmental effects of high meat consumption, and it is important for the meat industry to try to address this awareness [1, 2]. One way of doing this could be to produce new products in which the meat constitutes a smaller percentage of the total product by adding a significant amount of other natural ingredients, e.g. vegetables.

This study is part of a project aimed at improving the possibilities for Danish companies to produce new and untraditional meat products. The idea is to show how meat can be combined with other ingredients to make new and healthy products with a high eating quality and an acceptable shelf-life.

Besides developing new products, it is also desirable to develop products that can be used in new eating situations, for example snack products eaten between meals [3]. When these product ideas are converted into real products, it is hoped that they will give added value to meat products, thereby increasing the market share for the Danish meat industry by creating new market segments. Products that provide a high level of natural protein combined with vegetables can provide a higher nutritional value to a market for snack products in which many products today contain high levels of fat, carbohydrates and sugar.

II. MATERIALS AND METHODS

Spreads: two types of spread were produced.

Butternut: 40% pork filet, 50% butternut and carrot, lemon juice, stock, lovage, salt and pepper.

Double Pea: 40% pork filet, 40% green pea and split pea, stock, horseradish, leek, citric acid, salt and pepper.

Production of the meat spread: pork filet (heat-treated at 58°C for 6 hours), vegetables (thawed), seasoning, stock and salt were chopped in a bowl chopper until a smooth texture was obtained. The spreads were subsequently either vacuum-packed in pouches (PEPT 12/PEP LLDPE size 230x300mm) with 400g in each and pasteurised at 75°C for two minutes or MA-packed with 30% CO_2/70% N_2 in trays (Färch PP 71-51A size 200x140mm) with top seal (Top seal Pet Map PB 62) with 400g in each tray.

An overview of the samples included in the present study can be seen in Table 1.

Table 1. Spreads included in the study

Spread	Packaging	Preservation	Abbreviation
Butternut	MA-packed	1% Na-lactate	But-MAP
Butternut	Vacuum	Pasteurisation	But-past
Double pea	MA-packed	1% Na-lactate	Pea-Map

Chemical analysis: the spreads were analysed for sodium chloride [4], water [5], protein [6], fat [7] and pH [8].

Shelf-life: in the sensory study, microbiological analyses were performed after 0, 7, 21 and 28 days' storage at 5°C. Furthermore, sensory analyses were performed after 7 and 21 days' storage at 5°C, and the references samples were stored at 0°C.

Microbiological analysis: the samples were 10-fold diluted and pour-plated in Brain Heart Infusion (BHI Oxoid), and the total counts were enumerated after incubation at 20°C for 5 days. The microbiological safety of the spreads was evaluated by predicting the growth of *L. monocytogenes* and *C. botulinum* using DMRI predictive models [9] and [10].

Sensory analysis: samples stored at 0°C and 5°C respectively were served in small cups (Solo, B200EN, black, 59.1 mL), each containing 15g, which were then tempered to 15°C at room temperature.

Each spread was evaluated using a triangle test and a paired comparison test. When performing the comparison test, the panellists were asked if they could find a difference between the reference (0˚C) and the three spreads (5˚C, *But-MAP, But-past and Pea-MAP*). If so, they were then asked to evaluate the difference on a scale and describe the difference.

Differences were evaluated for appearance, flavour and texture, on a scale ranging from 0-4. This difference could indicate whether the sensory quality was affected during storage.

Consumer test: a consumer test was conducted as a central location test at two different locations, a school and a consultant company, in order to include different segments. The test included two spreads: *But-past* and *Pea-MAP*.

A total of 137 respondents (94 males and 43 females) with a mean age of 32 years were included. Consumers were given a questionnaire containing background questions, a rating of 12 holistic attributes and liking of the products on a 9-point hedonic scale and finally questions on how the product could be used. The 12 holistic attributes were chosen from a preliminary check-all-that-apply (CATA) list.

The statistical analysis was performed using PanelCheck V.1.4.0 (MATFORSK, Norway) [11].

III. RESULTS AND DISCUSSION

Chemical analysis: the spreads had a very low fat content between 0.7-3.8%, a low salt content of just above 1% and a relatively high protein content between 11.1-14.8% (Table 2).

Table 2. Results from chemical analyses of fat, protein, carbohydrates (calculated), pH, salt and water

Spread	*But-MAP*	*But-past*	*Pea-MAP*
Fat %	0.7	0.8	3.8
Protein %	11.3	11.1	14.8
Carbohydrates* %	2.3	2.3	8.5
pH	5.1	5.1	5.2
Salt %	1.10	1.12	1.09
Water %	81.7	80.8	69.4

* Indicates values that are calculated in WinFood 4.0.

The calculated energy content and energy distribution in percentages are shown in Table 3. As can be seen in the table, they do not meet the Nordic Nutrition Recommendations (NNR) for the overall diet [12]. Since the spreads are only intended to be eaten as part of a meal (e.g. in a sandwich or as a dip with, for example, crackers), the energy distribution of the total meal will change. The spread is a good source of natural protein with an energy distribution of 47-75% for protein. Furthermore, it has a very low fat content compared with other spreads and snack dips on the market. The products meet the requirements set in the study to develop a new meat product that has a low content of salt and fat and is a good source of protein.

Table 3. Calculated energy content and Energy percentages (E%)

Spread	*But-MAP*	*But-past*	*Pea-MAP*	*NNR*[1]
Energy kJ/100g	257	257	537	
Fat E%[2]	10	10	26	≤30
Protein E%[2]	75	75	47	15-20
Carbohydrates E%[2]	15	15	27	55-60

[1]Nordic Nutrition Recommendations (NNR)
[2]Calculation: ((content in g/100g)*(energy/gram macronutrient)*100) / (total energy content)

Microbiological shelf-life: The non-pasteurised spreads had a total count of between log 7.6 and 8.6 after 21 days (Table 4). The shelf-lives of the non-pasteurised spreads in this study were between 7 and 21 days. For *Pea-MAP*, this corresponded to the sensory analyses in which a sour taste was detected, whereas no changes in the taste were detected in *But-MAP*. For the pasteurised meat spread, the shelf-life was at least 28 days, because no increase in the total count was observed during 28 days' storage. This corresponded to the sensory results.

Table 4. Total count for Butternut spread (MA-packed or pasteurised), and Double Pea spread (MA-packed).

	Log CFU/g +/- Std.			
Spread	Day 0	Day 7	Day 21	Day 28
But-MAP	3.7 ±0.3	5.0 ±0.1	8.6 ±0.0	8.7 ±0.1
But-past	3.7 ±0.3	2.7 ±0.4	3.8 ±0.0	3.6 ±0.3
Pea-MAP	3.1 ±0.1	3.1 ±0.3	7.6 ±0.1	8.5 ±0.1

Microbiological safety: all three products can be regarded as microbiologically safe, due to no-growth of *C. botulinum*, and, in the non-pasteurised product, growth of *L. monocytogenes* is prevented by the addition of 1% sodium lactate.

Sensory analysis: the triangle test (Table 5) showed a significant difference between *Pea-MAP (5°C)* and *Pea-MAP (0°C)*, even after seven days ($p < 0.01$). The significance level increased after 21 days of storage ($p < 0.001$), indicating that the sensory quality of *Pea-MAP* had changed during storage. No significant difference was observed for *But-MAP* and *But-past* over time.

Table 5. Number of correct responses out of total responses (16), and the corresponding significance level for each storage time

	7 days		21 days	
Spread	Correct answers	p	Correct answers	p
But-MAP	4/16	ns	4/16	ns
But-past	8/16	ns	5/16	ns
Pea-MAP	9/16	*	14/16	***

Eight panellists did the triangle test two times = 16 answers.
Levels of significance: p>0.05=non-significant (ns); 0.05>p>0.01=*; 0.01>p>0.001= **, p<0.001=***

This was in accordance with the high total count from the microbiological analysis (Table 4). Thus, the high total count is most likely the reason for the large increase in the difference between the reference and sample for *Pea-MAP*, which was described as sour, lemon, acid and vinegar (Table 6). In *But-MAP*, the taste was not affected by the high total count at day 21.

Table 6. Mean values (eight panellists) from the scoring of differences between 0˚C and 5˚C samples

Spread	*But-MAP*		*But-past*		*Pea-MAP*	
Days	*7*	*21*	*7*	*21*	*7*	*21*
Appearance	0.4	0.6	0.6	0.5	1.1	0.6
Flavour	1.3	1.1	0.6	1.4	1.5	3.1
Texture	0.6	0.5	0.9	0.4	0.9	0.6

Scoring scale: 0 = no difference, 1 = just detectable, 2 = weak, 3 = distinct, and 4 = strong

It was expected that product differences due to prolonged storage would increase over time, but this was not the case for all attributes. Only the flavour in *But-past* and *Pea-MAP* had a more pronounced difference over time (Table 5). For *But-past*, it was only a "just detectable" to "weak" difference in flavour intensity that was not in accordance with the results from the microbiological analysis. Here, the number of CFUs was stable during all 28 days measured (Table 4).

Consumer test: it was found that *Pea-MAP* was significantly more liked than *But-past* for overall liking, with mean values of 5.4 and 4.9 respectively ($p<0.05$), measured on a 9-point hedonic scale. Looking at the two different segments, the consultancy company (mean age 42y) had a higher mean liking for *But-past* of 5.3 whereas the school (mean age 20y) had a mean

liking of 4.4 ($p<0.05$). Likewise for *Pea-MAP* the consultancy company had a higher mean liking of 5.8 compared to the school with a mean liking of 4.7 ($p<0,001$). Males had a higher liking for *Pea-MAP* ($p<0.05$), but for *But-past* no difference was observed between genders. The respondents' frequency of pork meat consumption did not seem to affect their liking for the spreads significantly, the average pork consumption being 2-3 times a week.

In the holistic test, the consumers described the *Pea-MAP* primarily as *healthy*, *fresh*, *appetising*, *rich in protein*, *natural*, *trendy* and *exciting*, whereas the attributes *inviting*, *surprising*, *new*, *different*, *boring* and *strange* were used most to describe the *But-past*.

For consumption, most consumers chose dip (54%) or sandwich spread (46%) as the best use for the spreads.

IV. CONCLUSION

It was possible to develop new healthy meat spreads with a high vegetable content. All spreads had a very low fat content of between 0.7 and 3.8%, a low salt level (1.1%) and a protein content of between 11.3 and 14.8%. The spreads are therefore a good source of natural protein. The low fat and salt content and the relatively high protein content make the spreads a healthy alternative to other spreads and snack dips currently available on the market.

A consumer test showed that the Double Pea spread was the most liked. Consumers described the *Pea-MAP* primarily as *healthy*, *fresh*, *natural*, *trendy*, *appetising*, *rich in protein*, and *exciting*, whereas *But-past* was described as *inviting*, *surprising*, *new*, *boring* and *strange*.

54% of the consumers could see the products used as a dip and 46% as a sandwich spread.

The non-pasteurised spreads had a microbiological shelf-life of between 7 and 21 days, and the pasteurised spreads a shelf-life of at least 28 days. The sensory quality of the pea spread changed significantly after 21 days' storage at 5°C, whereas only minor or no changes were observed in the two butternut spreads.

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REFERENCES

1. Jiménez-Colmenero, F.; Carballo, J.; Cofrades, S. (2001). Healthier meat and meat products: Their role as functional foods. Meat Science 59:5-13.
2. Zhang, W.; Xiao, S.; Samaraweera, H.; Lee, E.J.; Ahn, D.U. (2009). Improving functional value of meat products. Meat Science 86:15-31.
3. Verbeke, W.; Pérez-Cueto, F.J.A.; de Barcellos, M.D.; Krystallis, A. (2010). European citizen and consumer attitudes and preferences regarding beef and pork. Meat Science 84:284-292.
4. NMKL method no. 178, 2004: Chloride (salt). Determination in foods by potentiometric titration.
5. NMKL 23, 1974, 2rd Ed. Moisture and ash. Determination in meat and meat products
6. Mod. a. AOAC Official Method 981.10: Crude protein in meat. 1983.
7. Mod. a. NMKL No 131, 1989: Fat. determination according to SBR (Schmid-Bodzinski-Ratzlaff) in meat and meat products.
8. ISO 2917 (1974) for Meat and meat products: Measurements of pH.
9. DMRI Listeria model: http://3.test.dezone.dk/Default.aspx assed the 11.04.2013
10. DMRI C. botulinum model. http://3.test.dezone.dk/Default.aspx assed 11.04.2013
11. http://www.panelcheck.com/
12. NNR Nordic Council of Ministers (2004). Nordic Nutrition recommendations 4th edition. Nordic Council of Ministers.