Meat products containing hydrolysed by-products – a health perspective

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Worldwide, approx. 26% of the adult population suffer from hypertension. Hypertension is a significant contributor to cardiovascular diseases. Interestingly, hydrolysed proteins may display anti-hypertensive activity, which has a huge potential in future efforts against hypertension. Hydrolysed proteins based on raw materials of animal origin, including low value cuts and by-products, can be added to meat products. Furthermore, this will also increase the protein concentration, a benefit for many elderly people suffering from protein deficiency. However, the flavour characteristics of hydrolysates in general can be chemical and/or bitter. The aim of the presented study was to evaluate the sensory characteristics of Danish meat products with added hydrolysed by-products using a trained panel and consumers. The hydrolysates were added individually to the meat products before the final processing. The sensory evaluations showed different intensities of chemical flavour in the meat products depending on the added hydrolysate. The consumers rated some of the meat products with added hydrolysate as being equally appetizing as the reference. This underlines the potential that lies in the application of hydrolysate as a health-promoting ingredient. The future goal is to identify the perfect match between a given hydrolysate and the host meat product.

Key Words – Bioactive peptides; hypertension; protein deficiency

I. INTRODUCTION

Hypertension, the medical term for high blood pressure, is a significant contributor to cardiovascular diseases and an increasing problem worldwide. Recent estimates show that approximately 25% of the adult population (25 years and over) in the world suffer from hypertension [1] and that cardiovascular diseases will be the most prevalent cause of death by 2020 [2]. This issue needs to be addressed. Inspiration can be found from ancient Greece in a quote by Hippocrates: "Let food be thy medicine and medicine be thy food". Meat products showing health-promoting bioactivity have promising potential in efforts to reduce the constantly increasing number of people suffering from hypertension.

Another issue that needs to be addressed is the fact that there is an increasing number of people worldwide, especially among the elderly, who suffer from protein deficiency. The challenge for this group is their decreased appetite. By adding proteins to, for example, meat products, the protein concentration increases substantially and the elderly do not need to eat a large amount of food, which is a clear advantage.

In the past decade, studies have shown examples of peptides derived from meat that demonstrate anti-hypertensive activity [3]. This opens up the possibility of producing designed meat products with health-promoting properties and at the same time increasing the value of, for example, by-products and other low-value meat cuts. When producing healthy foods, it is equally important that the eating quality is high, as otherwise people would most likely avoid these products despite their beneficial health effects. This might be a challenge with hydrolysates in general, since these may result in chemical and/or bitter flavour characteristics.

The aim of this study was to evaluate the eating quality of traditional Danish meat products with added hydrolysates. The meat products were assessed both by a trained sensory panel and by Danish consumers.

II. MATERIALS AND METHODS

Four commercially available hydrolysates were used in the study. They were produced using the following raw materials: neck trimmings, beef greaves, pork greaves and pig liver. The

hydrolysis was performed with Alcalase®, Protamex® and Flavourzyme® (Novozymes, DK) at approx. 55°C for one hour and was then terminated by heating to 90°C followed by spray-drying. Each hydrolysate was tested for anti-hypertensive activity using the ACE inhibitory assay [3]. Four Danish meat products, all based on pork, were produced using traditional recipes: wiener sausage, fermented sausage, liver paste and meat balls. The hydrolysates (concentration of 8% (weight)) were added individually to the products before processing. A reference of each product without added hydrolysate was also produced and evaluated in the sensory tests. In the sensory tests, the meat products were served cold. The consumers were given rye bread with the meat products, as these are normally consumed together. The trained panel performed a sensory profile analysis (unstructured line scale from 0-15), while the consumer survey was based on associations with abstract words, such as "traditional", "appetizing" and "chemical" (scale 0-15).

III. RESULTS AND DISCUSSION

All four hydrolysates showed anti-hypertensive activity corresponding to carnosine, which was used as a control in the assay (Table 1).

Table 1. Anti-hypertensive activity for each hydrolysate and carnosine

Hydrolysate	IC_{50} (mg/ml hydrolysate)
Pig Shield bloody meat (BM)	16
Pork greaves (PG)	10
Beef greaves	9
Pig liver (L)	11
Carnosine	14

IC_{50} is the concentration needed for a 50% inhibition of the ACE enzyme central to blood pressure regulation. The lower the concentration, the higher the activity.

The sensory profile of the meat products revealed an interesting interaction of flavour characteristics between a given hydrolysate and the meat products. For example, the off-flavour of liver paste with hydrolysed pork greaves was clearly lower than when the product was wiener sausage. Furthermore, some of the hydrolysates had a more pronounced chemical flavour than others (several hydrolysates were tested in a pre-study but were taken out of the study). It was expected that the meat products would contain some chemical flavour, since the concentrations added were relatively high and since no attempt was made to mask this flavour. The results of the sensory profile of liver paste are shown in Table 2 (please see the poster for all meat products).

Table 2. Sensory profile of liver paste. Different letters in superscript indicate a significant difference.

	PG	**L**	**BM**	**REF**
Odour				
Liver	5.1^{abc}	8.0^{a}	3.1^{c}	6.2^{ab}
Spicy	5.1^{ab}	5.0^{ab}	3.5^{b}	5.6^{a}
Burnt	3.4^{b}	6.5^{c}	1.7^{ab}	0.6^{a}
Soy	2.5^{a}	7.3^{b}	2.0^{a}	0.8^{a}
Surface colour				
Brown	6.2^{a}	11.2^{b}	5.8^{a}	5.0^{a}
Flavour				
Liver	5.9^{ab}	8.5^{b}	3.1^{a}	4.9^{a}
Spicy	5.2^{ab}	5.5^{b}	4.1^{a}	5.2^{ab}
Salt	2.2^{a}	3.7^{b}	2.3^{a}	1.9^{a}
Sour	3.7^{a}	5.5^{b}	4.7^{ab}	3.8^{a}
Bitter	5.6^{a}	9.4^{b}	6.3^{a}	4.3^{a}
Soy	2.3^{a}	7.6^{b}	2.2^{a}	1.0^{a}
Off	2.7^{a}	3.8^{a}	8.1^{b}	1.8^{a}
Texture				
Firm	7.3^{b}	6.6^{ab}	9.2^{c}	5.2^{a}
Coarse	6.4^{a}	6.6^{a}	4.7^{b}	6.7^{a}
Creamy	6.5^{a}	7.3^{ab}	8.4^{b}	6.1^{a}
Aftertaste				
Bitter	5.2^{a}	8.7^{b}	5.4^{a}	3.9^{a}

PG: hydrolysed pork greaves, L: hydrolysed liver, BM: hydrolysed neck trimmings; REF: reference

The consumers evaluated the meat products served on rye bread. The consumers were canteen users and were recruited at different workplaces during their lunch break. A total of 85 consumers evaluated the liver paste using abstract words. These words are used in everyday language. The results of the consumer survey for liver paste are shown in Table 3 (please see the poster for all meat products).

Liver paste is a very traditional meat product and is included in many children's packed lunches almost every day. This is probably the reason why it is rated as rather boring. Furthermore, it can be seen from Table 3 that the reference is the most appetizing, followed by the liver paste with added hydrolysed pork greaves. However, the differences were not significant.

Table 3. Consumer evaluation of liver paste. Different letters in superscript indicate a significant difference.

Abstract word	PG	L	BM	REF
Traditional	8.4^{ab}	7.2^{a}	7.2^{a}	9.0^{b}
Different	7.3^{b}	9.5^{a}	9.4^{a}	7.7^{b}
Familiar	8.1^{bc}	6.8^{ab}	6.5^{a}	8.8^{c}
Strange	7.4^{ab}	8.7^{a}	8.9^{a}	6.1^{b}
Boring	9.6	8.6	9.6	8.7
Exclusive	5.1^{ab}	5.3^{ab}	4.7^{a}	6.3^{b}
Discount	8.3^{bc}	8.7^{abc}	9.9^{a}	7.8^{c}
Appetizing	6.8^{abc}	6.2^{ab}	5.9^{a}	7.8^{c}
Natural	7.5^{ab}	7.5^{ab}	6.6^{a}	8.6^{b}
Chemical	7.0^{ab}	7.2^{ab}	7.7^{a}	5.8^{b}

PG: hydrolysed pork greaves, L: hydrolysed liver, BM: hydrolysed neck trimmings; REF: reference

When comparing the sensory profile and the consumer survey, it is interesting to note that the paste with added hydrolysed neck trimmings was scored very differently with regard to off-flavour (panel) and chemical flavour (consumers). In this study, these two flavours were regarded as being quite similar.

The panel rated this paste as having a significantly higher degree of off-flavour than the other pastes. However, the consumers rated this paste as having the same level of chemical flavour as the other pastes (except for the reference). This could indicate that consumers may not be particularly sensitive towards the chemical flavour introduced by the hydrolysates. In fact, hydrolysed pork greaves added to wiener sausages were rated as being slightly more "appetizing" than the reference.

Taking into account the high concentration of hydrolysates added to the meat products and the fact that product development or flavour improvements were not performed, the sensory results show a promising potential for the application of the hydrolysates. The challenge is to identify the perfect match between hydrolysate and product in order to optimise both the bioactivity and the flavour.

Furthermore, as previously mentioned, the hydrolysates can also be used as protein boosters, resulting in a substantial increase in protein concentration. The protein content in the liver paste with added hydrolysed neck trimmings was increased by 33% compared with the reference.

In order to move forward, research efforts will need to focus on i) screening hydrolysates based on various raw materials for bioactivity, ii) identifying the perfect match between hydrolysates and meat products (or other food items) and iii) documenting the preservation of bioactivity in the processed meat products.

IV. CONCLUSION

The sensory evaluations showed different intensities of chemical flavour in the meat products depending on the added hydrolysate. The consumers rated some of the meat products with added hydrolysate as being equally appetizing as the reference. This underlines the potential that lies in the application of hydrolysate as a health-promoting ingredient.

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