

FINAL REPORT

Upgrading of side stream products

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1.0 EXECUTIVE SUMMARY

Globally, sustainability in food production is an area of focus. Meat producers are under pressure to reduce CO₂ emissions. At the same time, attention is given to the optimization of bio-resources within the food production chain, including the slaughterhouses. This optimization of by-products/side stream products/biomasses from slaughterhouses is directed towards an economic add-on as well as improvement of environmentally related factors. By moving raw material from feed to food, the CO₂ emissions are reduced, as the calculation of CO₂ emission is based on the amount of meat (proteins) that may be replaced.

The aim of this project was to present an overview of state of the art for utilization of proteins from side stream raw materials with focus on hydrolysed proteins. The goal was to gather knowledge related to quality, application, consumers, business potential, health and functionality related to the upgrading of slaughterhouse side stream proteins.

The knowledge has been found in the scientific literature, on company websites, through completion of an on-line consumer survey and finally, through short interviews with personnel within the Australian meat industry.

The requirements for using the side stream products from slaughterhouses are few but significant:

- Only side stream raw material from veterinary approved animals
- Hygienic collection of the raw material
- Preservation by e.g. chill storage or the use of antioxidants
- Food grade approval of protein production

Some of the proteins from side stream products like offal and blood have a high nutritional value due to the content of indispensable amino acids. As examples, proteins from beef tongue, beef lever and blood plasma have an optimal amino acid profile according to WHO directions for human health. Proteins from lamb sweetbread can also be considered a good protein source. Proteins possess several advantages related to human health:

- Provide energy
- Support muscle growth and maintenance
- Excessive proteins are not stored in the body (like fat and sugar)
- Increase satiation
- Can be used in weight loss and weight management

The health benefits of proteins are scientifically recognised, and several claims can be used in protein enriched food products.

Hydrolyses by enzymes and heat are well described and rather simple processes used in the industry today. It is also possible to hydrolyse using acid. However, this is not a widely used method, probably due to the high amount of salt in the final product, as attention in the food industry worldwide is on salt reduction. The enzymatically hydrolysed proteins have no functional properties and are primarily used for enrichment purposes. It is a known phenomenon that enzymatically hydrolysed proteins may possess off-flavours including a bitter taste. Proteins hydrolysed by heat have preserved some

functionality. However, if the goal is to produce proteins with functionality, then extraction is a method with possibilities, though not widely used in the industry.

The Australian consumers are generally not ready for proteins from slaughterhouse side stream products. The consumer survey revealed a strong reservation towards proteins from offal and especially from blood. When nutritional information was given, the consumers did not reduce their reservations towards proteins from offal and blood. Among the comments were “it sounds disgusting”.

In the survey, 622 consumers participated, and 225 were users of protein supplements. It is known from other surveys that consumers belonging to the so-called “fitness segment” are more likely to use protein supplements. For this reason, consumers performing sports were targeted in the recruitment process, though not specifically athletes at elite levels.

Among the 225 protein users, 53% were male and 47% were female. On average, 4-6 hours were spend on sports per week (26%), though a total of 30% of the consumers used more than 6 hours per week. The sports marked in the survey was running (58%), weightlifting in fitness centre (40%) and various team sports (total of 63%).

The reason for using protein supplements were “to fulfil protein requirements easy” and “to fulfil extra protein requirement”. Today the protein supplements used are based on dairy (57%) and plant protein (48%). However, meat proteins are used by 43% of the consumers. The most popular protein enriched products are protein bars and shakes, and these are the products to which the consumers prefer the addition of animal proteins. In a meal context, the consumers prefer the proteins to be added to meat and meat products.

The consumers were asked to rate the importance of different qualities of a protein supplement. Eating quality was rated highest followed by protein content. Factors like “amino acid composition”, “the product is recommended by others”, and “the effect is documented” were less important.

The main reason for starting up a production of proteins based on side stream products is the presence of a good business case. Today, export slaughterhouses sell some of the side stream products (Fancy meat) to e.g. the Asian market at good prices. In this case, the incentive for changing to a protein production may not be present. In academia societies, the focus on by-products from various industries has increased over the last few years. Focus is on the upgrading and recycling of biomasses, and the term “bio based society” is often used. Even though there is an estimated increased demand for proteins, and even though the proteins found in side stream products have a high nutritional value, there might still be a long way to go. Australian consumers have strong reservations against proteins from offal and blood, and how this can be handled and overcome is an important question. Production of protein ingredients from the side stream products has been mentioned as the obvious way to proceed.

2.0 INTRODUCTION

Background

Globally, sustainability in food production is an area of focus. Meat producers are under pressure to reduce CO₂ emissions. At the same time, attention is given to the optimization of bio-resources within the food production chain, including the slaughterhouses. This optimization of by-products/side stream products/biomasses from slaughterhouses is directed towards an economic add-on as well as improvement of environmentally related factors. By moving raw material from feed to food, the CO₂ emissions are reduced, as the calculation of CO₂ emission is based on the amount of meat (proteins) that may be replaced.

Purpose

The slaughterhouse side stream products are rich in several nutrients such as fats and proteins. In addition, the overall purpose of this project was to present an overview of state of the art for utilization of proteins from side stream raw materials focussing on hydrolysed proteins.

Scope

The scope of this project was related to beef and lamb side stream products. However, the knowledge gathered in this project is believed to be valid and applicable for animal side stream products in general. Some of the research results used in this project are based on pig side stream products.

Objectives and approach

The objectives of this report were based on six main areas: quality, application, functionality, health, consumer attitudes and business potential. The approach to cover these areas was:

- Search for valid knowledge within the scientific literature and in internet databases etc.
- Conduct an on-line survey among Australian consumers to gather knowledge concerning attitudes towards proteins of animal origin
- Interview personnel within the Australian meat industry for the discussion of potentials and obstacles for the upgrading of side stream products.

Limitations

This project was conducted as a desktop research. The major limitation was the existing literature on especially lamb side stream products, which was very scarce. The ground idea of the project execution was to use the “DMRI Model” with a group of stakeholders close to the project ensuring implementation of the knowledge and the results from the project activities. This proved somewhat difficult, which can be due to several reasons.

3.0 PROJECT OBJECTIVES

The overall objective of this project was to address and analyse six scientific areas of significance for the upgrading of side stream products from the slaughter of domestic animals focussing on beef and lamb.

The project objectives (scientific areas) related to beef and lamb side stream products as specified in the signed Agreement were as follows:

3.1 Overall quality

Categorize side stream products based on the content of major nutrient constituents found in the literature and food databases.

3.2 Application

Search for current applications of side stream products in food products available on the market.

Describe application opportunities for hydrolysed side stream products.

3.3 Functionality

Describe technological functionalities of and opportunities for side stream products.

Describe antioxidant bioactivity of hydrolysed side stream products.

3.4 Health

Describe the amino acid profile compared to WHO recommendations of side stream products and the matching health benefits.

Describe protein digestibility of lamb and beef side stream products.

Describe relevant health claims (e.g. health claims related to proteins).

3.5 Consumers

Describe consumer response to the addition of side stream products in food.

Describe sensory influences of hydrolysed lamb and beef side stream products added to food.

3.6 Business opportunity

Identify factors in the value chain that are important for succeeding in the upgrading of side stream products.

4.0 METHODOLOGY

This project has been based on desktop research. The reports and catalogue developed have included knowledge from the following:

- Scientific literature (journals), PhD thesis and Master thesis
- Interview with personnel associated with the Australian meat industry
- DMRI reports on conducted studies
- Databases e.g. USDA National Nutritional Database, MLA statistics
- Internet search for e.g. commercially available protein enriched products
- Consumer survey, internet based questionnaire sent to Australian consumers

The consumer survey targeted the ordinary Australian consumer. Though, with an overweight on

people using fitness centres, as previous studies showed that they are more likely to use protein supplements than other people are.

5.0 PROJECT OUTCOMES

This project had three scientific deliverables, a state of the art report, a report on consumer survey results and a catalogue for the industry. The idea behind the catalogue was to create an overall view of the results and knowledge obtained in the state of the art report and the consumer survey report.

State of the art

In the following, main findings from the report are represented in short; please look in the original report for references.

Raw material

In a cow (live weight of 583 kg, carcass weight of 295 kg), the amount of by-products is 288 kg. Hide (11.3 kg) and blood (7.6 kg) being the two major constituents of the side stream products. On the carcass, approx. 53 kg are bones and waste trim. On a lamb, bones constitute the largest percentage of the side stream products followed by rind, hide and organs.

Generally, the major nutrients in side stream products are proteins and fats. The liver (beef and lamb) has the highest contents of proteins (20 g/100 g), while mechanically separated meat followed by pancreas has high contents of fat.

Blood is a special case within the group of side stream products, partly due to the present increasing interest from various research groups, an interest based on nutrition and sustainability. The plasma fraction is already well known for its functionality (gelation) and widely used in the food industry. The present attention is among other focusing on the fact that a much larger percentage of the blood in the slaughterhouses worldwide could be collected and used for food or feed. In addition, attention is given to the complete amino acid composition of plasma according to WHO directions for a good protein source.

Hydrolysis and extraction

The state of the art report summarises the different methods of protein production including hydrolysis (heat, enzymes and acid) and extraction. These methods are the corner stones in the production of proteins from side stream raw materials (Figure 1).

Heat hydrolysis has been used for years in the production of soup stock based on bones as raw material. Roasting can be applied prior to the hydrolysis for the generation of roasted meat flavour.

Enzymatic hydrolysis is also a well-known process. Even so, there are challenges in the process due to the generation of bitter taste and off-flavours. In some cases, the off-flavours can be linked to the raw material used in the hydrolysis. Previous studies reveal that fermentation of the hydrolysed proteins is a feasible solution in order to minimise the off-flavours.

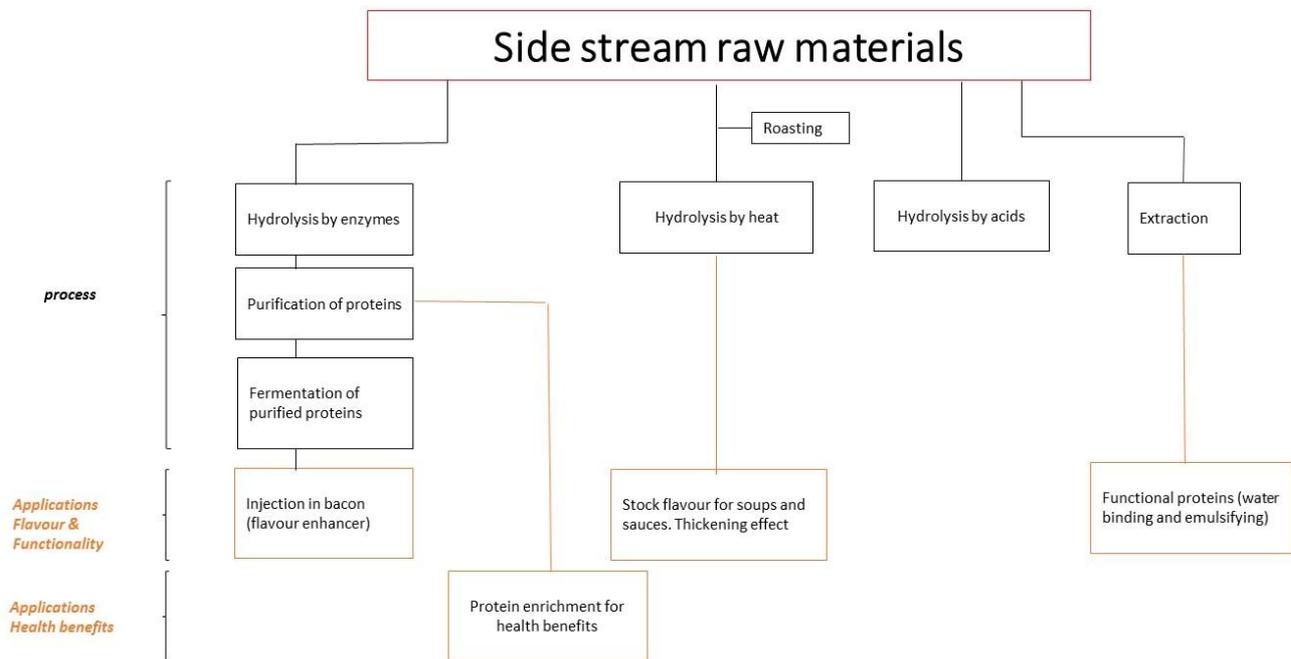


Figure 1. Overview of the reported processes for hydrolyses of proteins.

Very few reports can be found on acid hydrolysis, the process does not seem to be used by the industry. This can be due to the high concentration of salt after the hydrolysis.

Extraction may be an interesting approach due to the preservation of protein functionality, though few reports on the method have been published. These reports are of a more recent date, which can be a reason for the few available reports.

Nutrition and health

One of the major reasons for the interest in side stream products is the increasing demand for proteins. WHO has given directions for the composition of a complete protein, based on a minimum content of indispensable amino acids. Plasma, beef tongue and beef liver are examples of complete protein sources. With focus on the growing number of elderly (65+) within the world population and the evidence based recommendations for an increased intake of proteins for this consumer segment, researchers in particular, but also meat producers, are looking into the potential of using the side stream proteins. The other segment of great interest is the so-called “fitness segment”, they are among the protein supplement users of today.

In relation to an optimal protein source, it is also important to look at the digestibility of the protein source, as only ingested amino acids are used in the body metabolism. A recent study with enzymatic hydrolysed side stream showed that pig plasma had a DIAAS score of 97% followed by hydrolysed beef meat (83%) and hydrolysed pig heart (84%). Collagen from the connective tissue has a low content of indispensable amino acids, which is also reflected in the very low DIASS score.

Anaemia is prevalent in many parts of the world, including the western societies. The main risk factor of iron deficiency is related to the diet. Heme iron in meat is highly bioavailable, whereas the

bioavailability of non-heme iron is low. The absorption of non-heme iron is increased by ascorbic acid (drink orange juice with the meal) and by meat (the so-called “meat factor”). The mechanisms behind the meat factor is still not fully understood.

Bioactivity

Much interest has been given to the potential bioactivity properties of peptides, and researchers have investigated activities such as “antimicrobial”, “antioxidant”, inhibition of hypertension, prevention of diabetes etc. However, so far, none of the peptides has been approved by authorities including the European Food Safety Authority (EFSA). This means that no claim can be used for these peptides. To the best of our knowledge, only the peptide from the Japanese Bonito fish has been commercialised, which presumably has an inhibiting effect on hypertension.

Application

Regarding application of hydrolysed proteins to foods, it all comes down to the purpose of the protein addition (functionality, health) and then finding the perfect match between the protein and the food carrier. When adding enzymatic hydrolysed proteins, the potential off-flavour can be a challenge, and a masking strategy may have to be included.

Business potential

The business potential is highly dependent on the possibility of adding value to the slaughterhouse side stream products e.g. by the production of protein ingredients that meet market needs. The market for these proteins is challenged as consumers have reservations against proteins from offal and especially blood. The consumers think proteins from e.g. blood sounds disgusting, so marketing challenges have to be handled. However, pig plasma and gelatine are widely used in the food industry, so it may be all about “the right packaging”.

Consumer survey

In total, 622 consumers participated in the survey, of which 225 used protein supplements. The overall aim of the survey was to study the attitudes towards protein of slaughterhouse origin. In general, the consumers had strong reservations against proteins from e.g. offal and blood. The reservation was not readily changed by the inclusion of nutrient information. The most preferred protein enriched food products are within the “snack category” (bars and shakes), which may be the products to start with, when developing products enriched with side stream proteins.

It is important to acknowledge that the consumers did not taste any products in this survey. It is indeed difficult to imagine a tasty food product enriched with proteins from a source you find disgusting.

Data are supplied electronically as an Excel file.

Catalogue

The catalogue comprises headlines from the state of the art and the consumer reports.

The consumers pointed out eating quality as one of the most important factors for choosing a protein supplement or a protein-enriched product. Therefore, the catalogue also includes a few guidelines to easy sensorial evaluations of the products.

Interview with personnel associated with the Australian meat industry

The short interview was conducted by mail and involved:

A large Beef processor from South East Queensland.

Professor Robyn Warner, University of Melbourne

Niels Conradsen former employee at: Danpork, MeatConsult, KR Darling Downs, Castlemaine Bacon, Churchill Abattoir

Potentials in short

Cattle blood was pointed out as one of the side stream products that has an upgrading potential. At the same time, the potential is highly dependent on marked prices and the investment necessary to perform the upgrading.

Obstacles in short

Among the obstacles for upgrading are logistics, cost of set-up, food labelling directions and consumer reservations.

6.0 CONCLUSIONS/RECOMMENDATIONS

The positive facts concerning proteins from side stream products:

- Worldwide demand for more proteins.
- The value chain in and around the slaughterhouses contains large volumes of proteins.
- Proteins from meat and slaughterhouse side stream products do not contain allergenic proteins, as it is known from soy and whey.
- Some proteins derived from side stream (including offal and blood) have an optimal amino acid composition.
- Some proteins derived from side stream (including offal and blood) display functionality (e.g. gelation, water binding).
- The methods for protein utilization (e.g. hydrolyse) are available and fairly simple processes.

The challenges concerning the upgrading of proteins from side stream products:

- Australian consumers show strong reservations towards proteins from e.g. offal and blood, which are not readily changed by nutrient information. This challenge needs to be addressed across the food industry in order to handle consumer reservation and still meet the increased demand for more proteins.
- During the interviews, the Australian legal requirements regarding labelling were pointed out as an obstacle for the use of proteins from the different side stream products, as this may support or even increase the established consumer reservations.

- Side stream raw materials are perishable, and handling at the slaughterhouse (chill, adding antioxidants etc.) is paramount for the production of high quality proteins. The long distances alongside warm weather are inevitable challenges in some parts of Australia. For these reasons, the upgrading of side stream products can be limited to areas where several slaughterhouses are located (e.g. the east coast) and here can deliver to the protein producer. Alternatively, the bigger slaughterhouses in rural areas could establish their own protein process plant.
- Bioactivity of peptides has been the subject of research for several years. However, the subsequent commercial breakthrough is still awaiting. Furthermore, the authorities have not yet approved bioactivities with impact on human health.

7.0 BIBLIOGRAPHY

Please look in the original state of the art report for the references.