Additives in meat products – for good or for bad?

Professor Eva Tornberg, Lund University, Sweden

Additives and enzymes in food: past, present and future from a global and consumer perspective, 28-30 August, Falkenberg, Sweden

Joint publications with prof. Kerstin Lundström

1. Essen-Gustavsson, B., **Lundström, K**., Larsson, G., Lindholm, A., Nordin, A.C., Hansson, I. and Tornberg, E. The effect during growth of moderate exercise on **muscle metabolic characteristics** in vivo and relation to meat quality and sensory properties. 34th International Congress of Meat Science and Technology, Brisbane, part A, p. 27, **1988**.
2. Tornberg, E.; von Seth, G. Teori och metodik för mätning av köttkvalitet hos gris. I "Köttkvalitet hos våra slaktdjur". NJF-seminarium nr. 183. Eds. **Lundström, K**. och Malmfors, G. p. 109-118, Uppsala **1990**.
3. Johansson, G.; Tornberg, E.; **Lundström, K**. Meat colour in loin and ham muscles of normal meat quality from **Hampshire, Swedish Landrace and Yorkshire pigs**. International congress of Meat Science and Technology. 37th Proceedings, vol. I, 3:19, 394-397. Kulmbach, **1991**.
4. Johansson,M.,Josell,Å.,**Lundström,K.,**Enfält,A-C.,Hansson,I and Tornberg,E. Sensory quality of cured-smoked loins from carriers and non-carriers of the **RN-allele** in Hampshire crosses with low and high lean meat content. Proc.44th ICoMST, Barcelona, **1998**.
5. **Lundström,K**.,Enfält,A-C.,Hansson,I.,Essen-Gustafsson,B.,Johansson,M. and Tornberg,E. Technological meat quality in carriers and non-carriers of the **RN-allele** in Hampshire crosses with a low or high lean meat content. Proc.44th ICoMST, Barcelona,**1998**.
6. **Lundström,K.,** Enfält,A-C, Tornberg,E. and Agerhem,H. Sensory and Technological Meat Quality in Carriers and Non-carriers of the **RN-allele** in Hampshire Crosses and in Purebred Yorkshire Pigs. Meat Science vol.48,115, **1998**.
7. Lindahl, G., **Lundström, K**. and Tornberg, E. Contribution of pigment content, myoglobin forms and internal reflectance to the colour of pork loin and ham from **pure breed pigs**. Meat Science 59, 141-151, **2001**.

Some typical additives used in meat products

salt

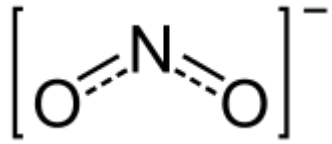
nitrite

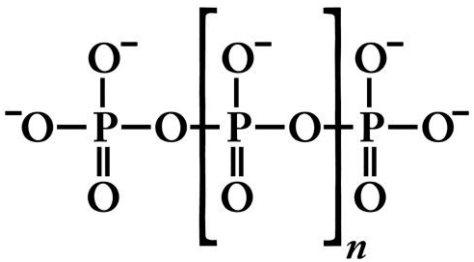
polyphosphate

antioxidants

potato starch

fibers





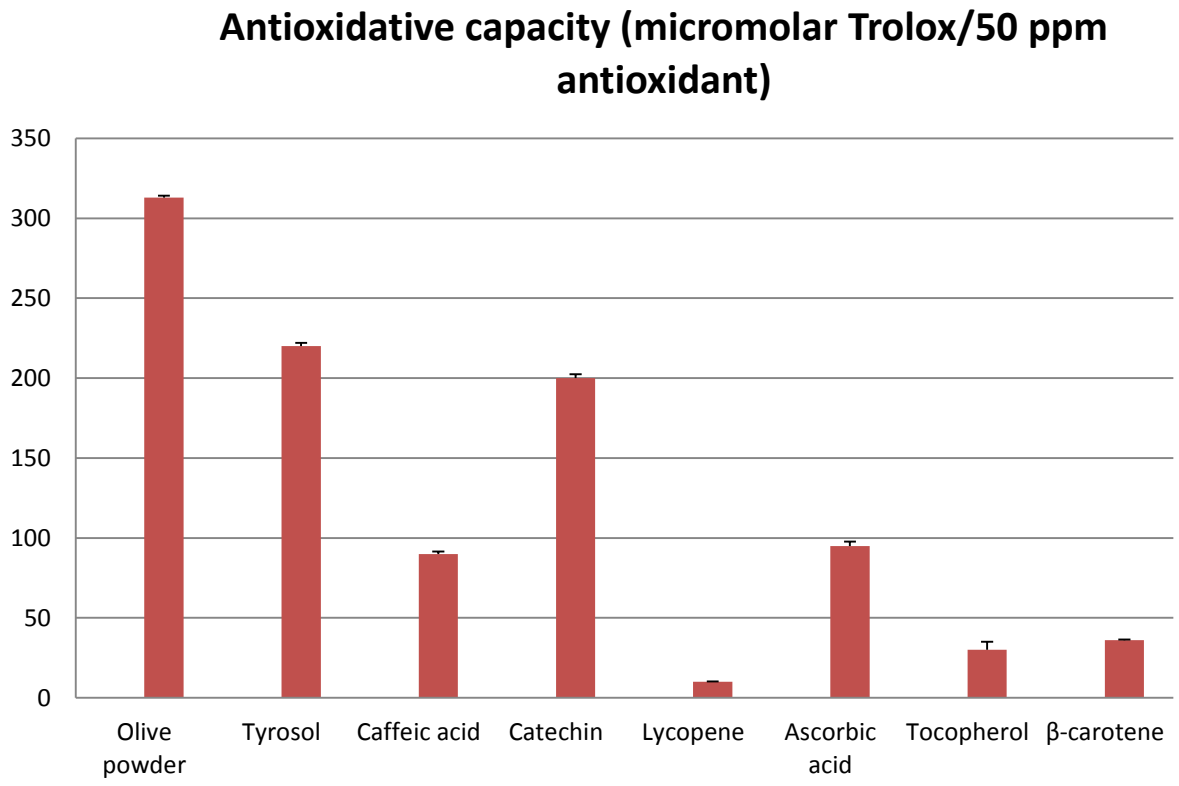
The influence of some additives on the quality of meat products – for good or for bad.

Quality aspects	Type of additive											
	Salt		Nitrite		Polypho sphate		Antioxi dants		Fibers		Potato starch	
Criteria	Goo d	Bad	Goo d	Bad	Goo d	Bad	Goo d	Bad	Goo d	Bad	Goo d	Bad
Health		X		X		X	X		X		X	
Hygien	X		X		X		X		-		X	
Pathoge nic	-		X		-		X		-		-	
Taste	X		X			X	X			X	X	
Texture	X		-		X		-		X	X	X	
Colour		X	X		-		X		X	X	-	
WHC	X		-		X		-		X	X	X	
FHC	X		-		X		-		X		X	

Antioxidants in meat products

- Besides microbial spoilage the major cause of quality deterioration in meat products is **oxidation**, which can cause a number of quality aberrations such as **colour changes, off-flavour formation, texture deterioration and water losses**
- The products formed during lipid oxidation can be **hazardous with regard to health**. Lipid peroxides can induce inflammation, DNA damage and tumor development, pathological conditions linked to **colorectal cancer**.
- Adding **antioxidants** could be a way to hinder the progress of oxidation in meat and thereby reduce the quality deviations and health hazards.

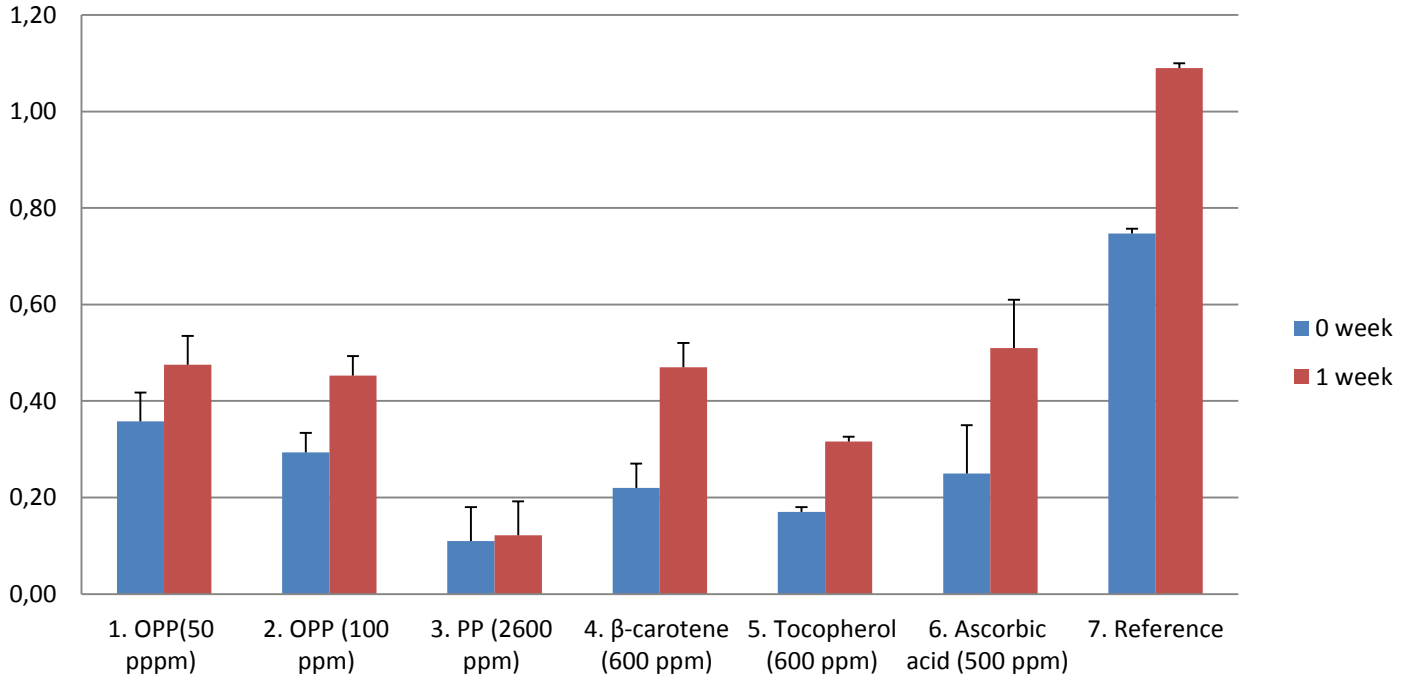
A comparison of antioxidant activity (scavenging activity with ABTS assay) between some Antioxidants.



The olive phenols and catechin are better antioxidants than the carotenoids.

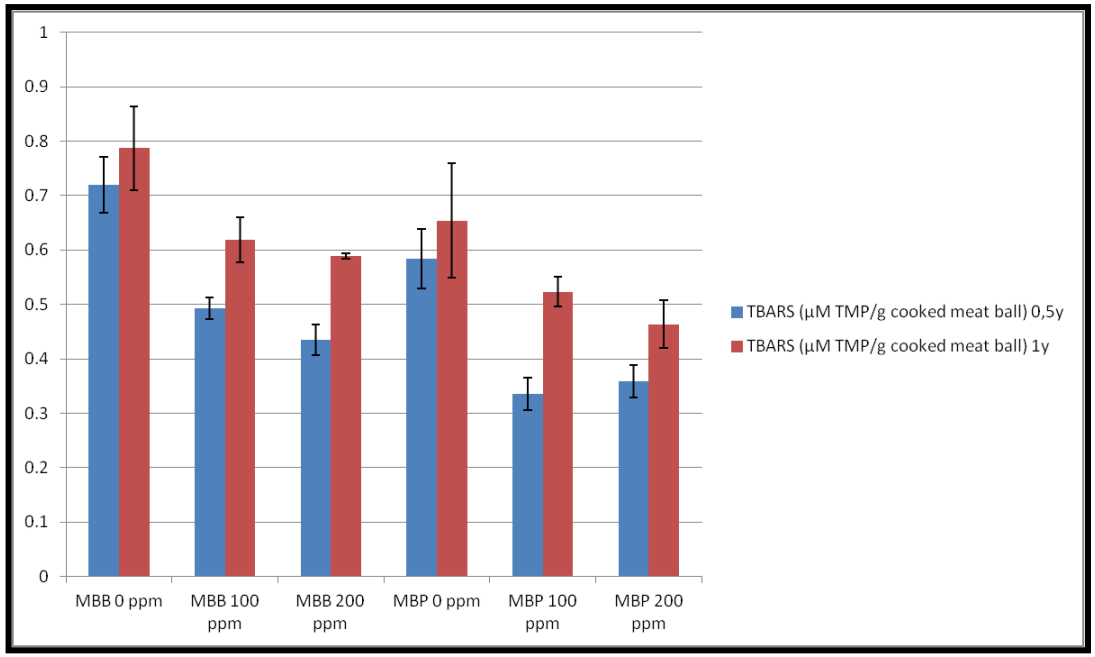
Cooked and chilled meat balls

Lipid oxidation (TBAR, µmol of TMP/(g·L))of meatballs (15% fat) deep fat fried after storage at 4°C 0 and 1 week.



Storage for 1 week at cold temp. increases lipid oxidation for all samples but mostly for the ref. Polyphosphates (2600 ppm) are the most efficient antioxidantes, which is 3-5 times more efficient than ascorbic acid and the fat soluble antioxidants.

Frozen storage of deep fat fried meat balls during 0.5 and 1 year with added antioxidants (OPP, 100 and 200 ppm)



MBB : 70% of beef meat.
MBP: 70% of meat, 42% beef and 28% pork

Even after half a year and a year of frozen storage the antioxidant OPP lowers significantly the lipid oxidation in meat balls

Dietary fibers

Dietary fibers originate mainly from *cell walls of root fruits, vegetables, fruits and cereals*.

For ***root fruits, vegetables and fruits*** *the insoluble part of the cell wall mainly constitutes of* ***hemicellulose/cellulose*** *and the soluble part mainly of* ***pectin.***

In ***cereals*** *there are two groups of fiber with special interest, namely* ***pentosanes*** *(i.e. arabinoxylanes and arabinogalactanes) and* ***β-glucanes.***

Composition of cereal fibers studied

	Total dietary fibre (% dm)	Arabinoxylans (% dm)	β-glucan (% dm)
Oat bran	18.4 (5.7)	5.2 (0.1)	10.2 (3.3)
Rye bran	36.0 (3.1)	25.6 (2.4)	4.2 (0.5)
Barley fibre	63.2 (26.1)	20.8 (2.3)	32.0 (22.3)

A comparison of rye bran , oat bran and barley fibre in low-fat **sausages and meat balls**

Important parameters of the recipes

Meatballs

- Water/protein ratio 7.4
- salt content 1.3%
- 4 or 8% added starch
- 1% total dietary fibre
- 9 or 1.5% fat

Sausages

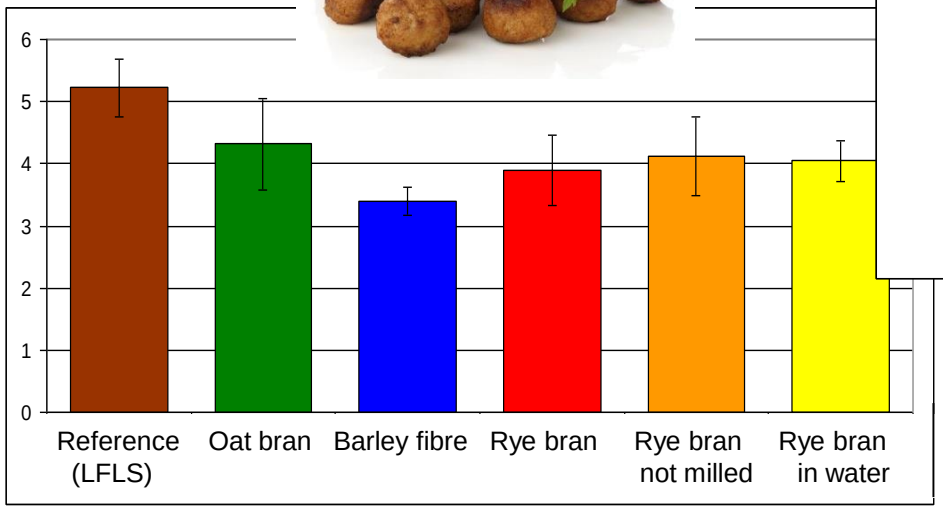
- Water/protein ratio 7.9
- salt content 2%
- 3.2 or 6.5% added starch
- 1% total dietary fibre
- 5 or 2% fat

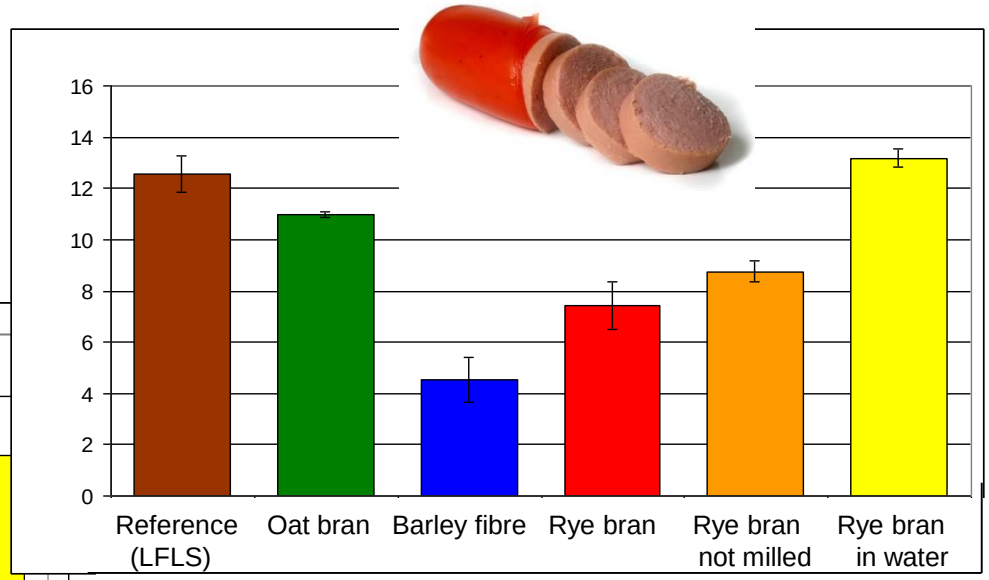
From Petersson, K., Godard, O., Eliasson, A-C and Tornberg, E. (2014) The effects of cereal additives on low-fat sausages and meat balls. Part 2: Rye bran, oat bran and barley fibre. Meat Science 96, 503-508.

Frying loss (%)

- The frying loss of the meatballs were high for all cereal additives.
- Sausages with oat bran had a decreased frying loss, while barley fibre and rye bran increased the loss.
- Rye bran that had been soaked in water had frying loss as low as the oat bran in sausages.

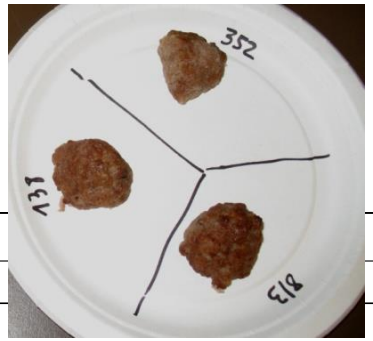
Firmness (N)

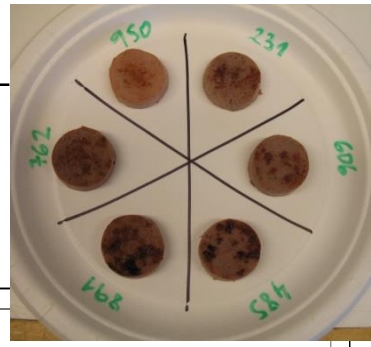




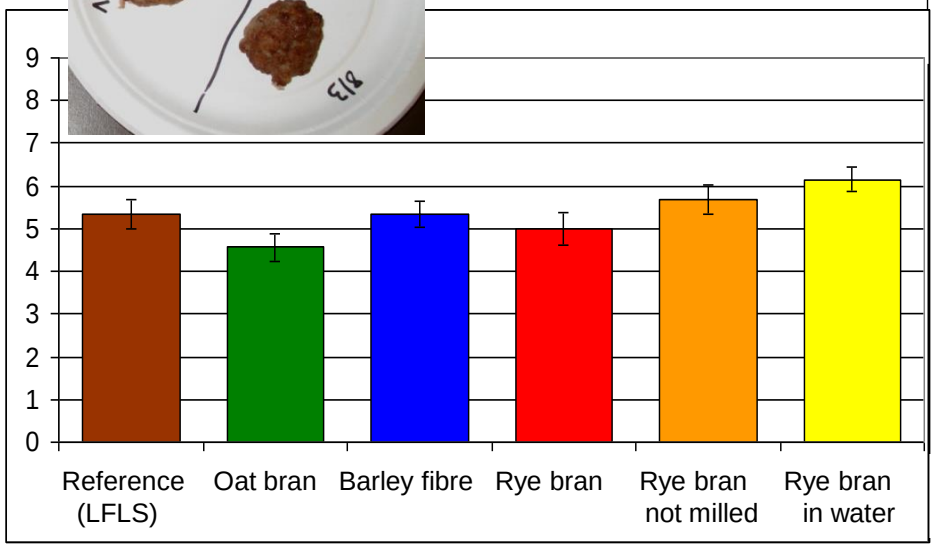
- Adding barley fibre resulted in a low firmness, especially for sausages
- The firmness of sausages with rye bran could be increased by soaking the rye bran in water, 50°C 4 hours

Sensory analysis – Total impression

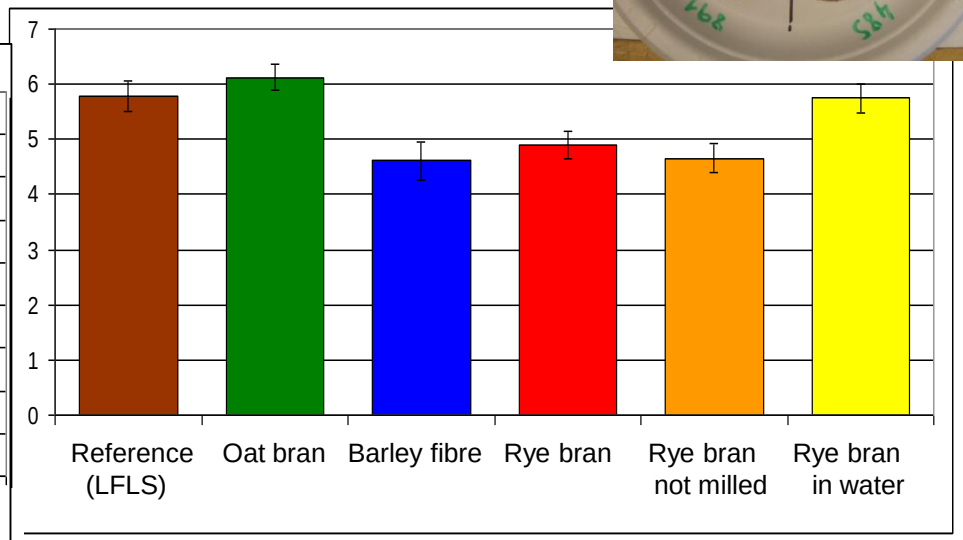




Meat balls



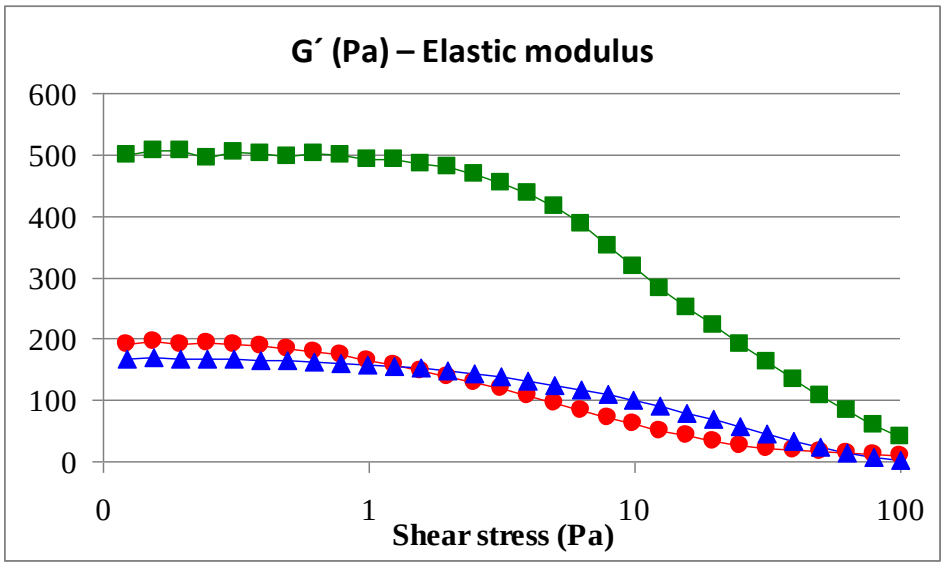
Sausages



- Oat bran was the most preferred additive in sausages while the least preferred in meatballs
- Barley fibre was the least suitable as additive in sausages
- Rye bran can be added to meatballs

Heating cereal additives and potato starch

Rheological measurements of heated mixtures of cereal additives and potato starch, according to the sausage recipes, without the meat.



Oat bran had a good gelling ability upon heating

- Oat bran + potato starch
- Barley fibre + potato starch
- Oat bran

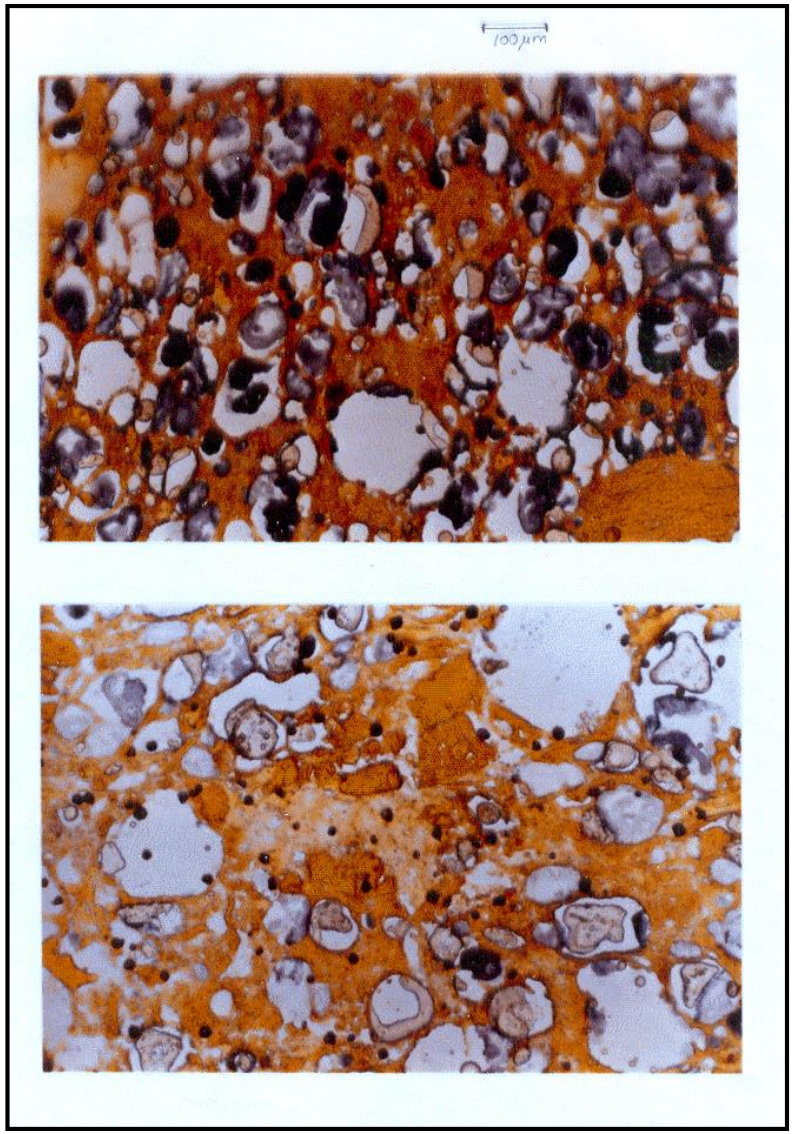
Conclusions

- Due to gelling ability upon heating, **oat bran** was most suitable for addtion to low-fat sausages, which received low frying losses and high values on both firmness and sensory acceptance.

- **Rye bran** is suitable for addition to low-fat meatballs probably due to its particulate nature. The gelling properties are not so important for meat balls as they are in sausages.

- The addition of **barley fibre** to low-fat sausages led to high losses and a very low firmness. This barley β-glucan could not form a gel when heated. A smaller molecular weight and a less favourable structure, compared to the oat β-glucan could be the the reason for that.

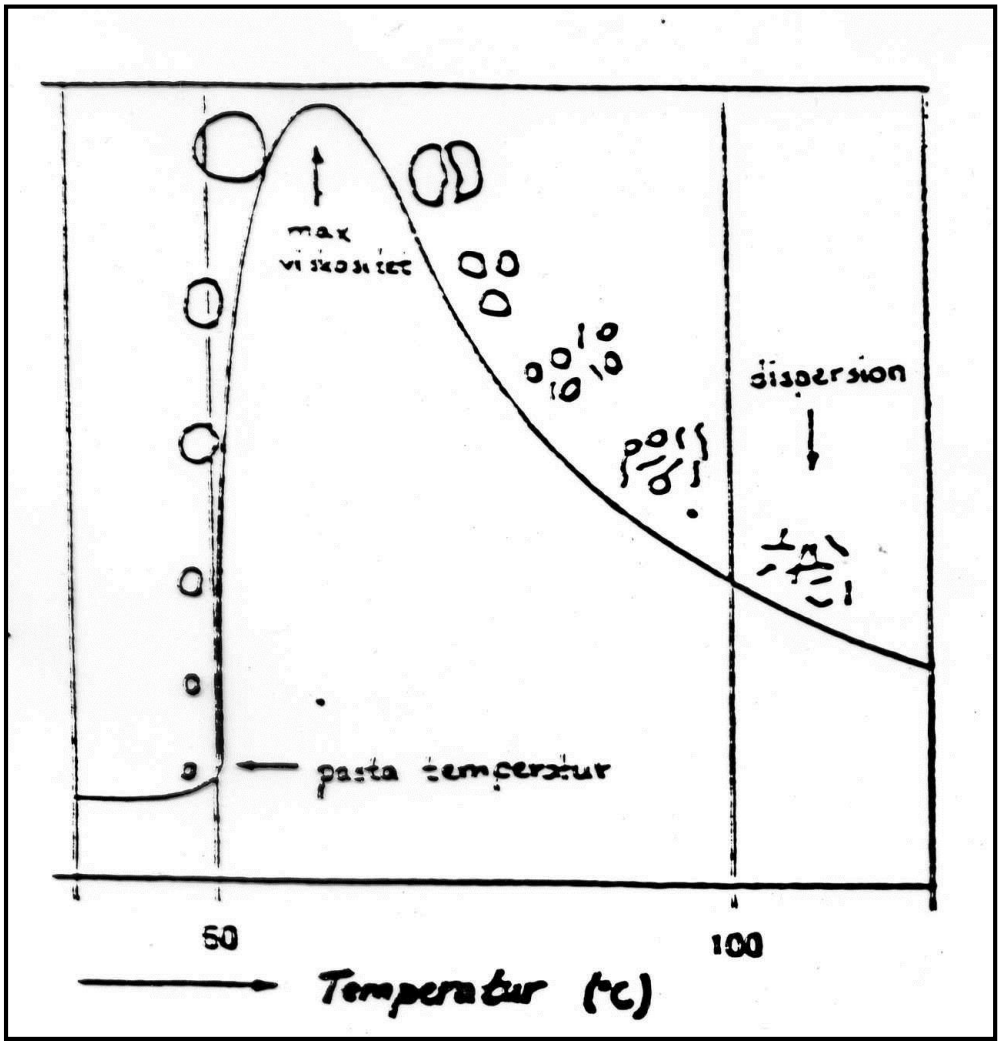
Potato starch added up to 4 % in emulsion sausages is common in Sweden



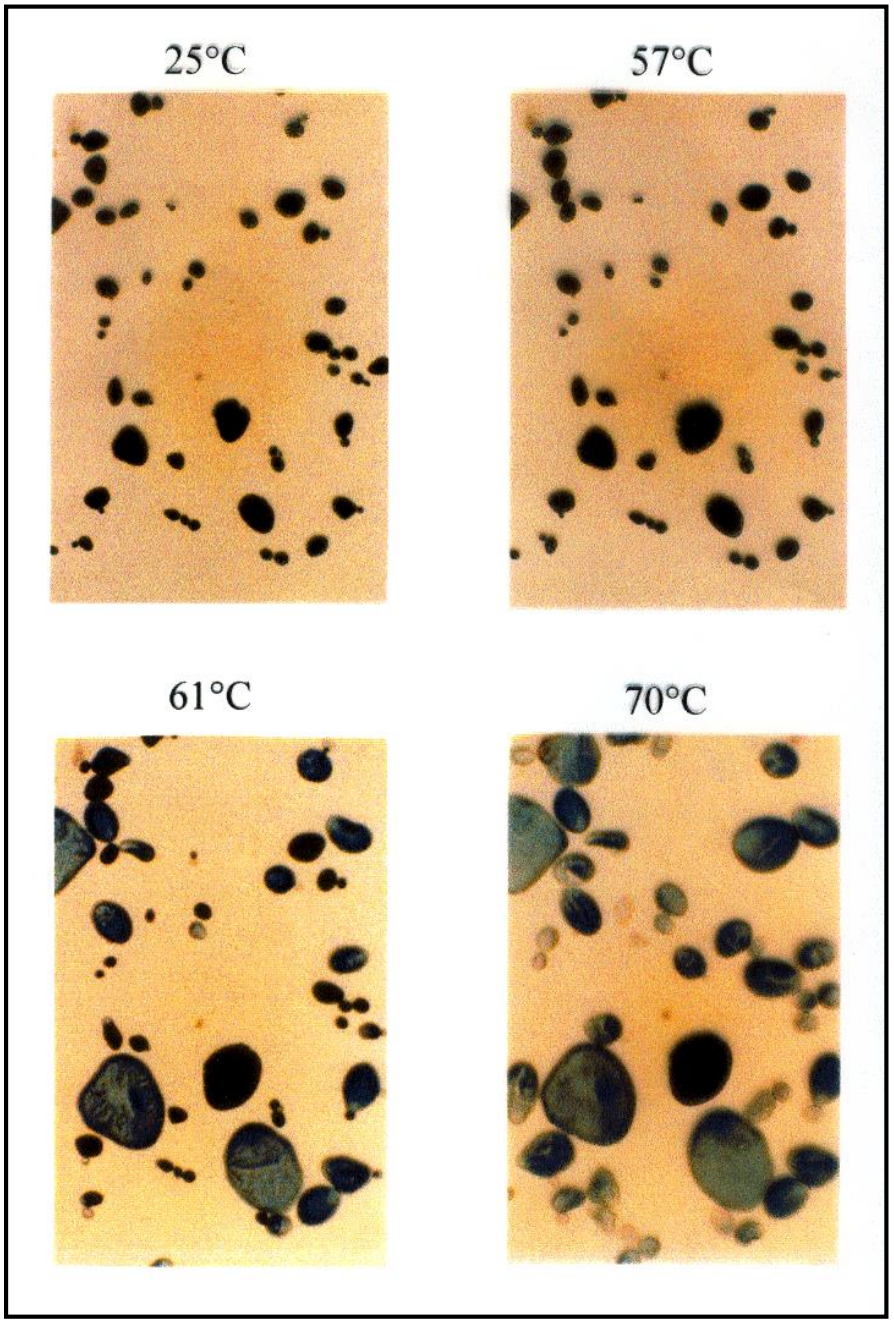
Potato starch granules are coloured black (iodine) and have a large variation in size in between sausages taken from production.

The general behaviour of starches on heating

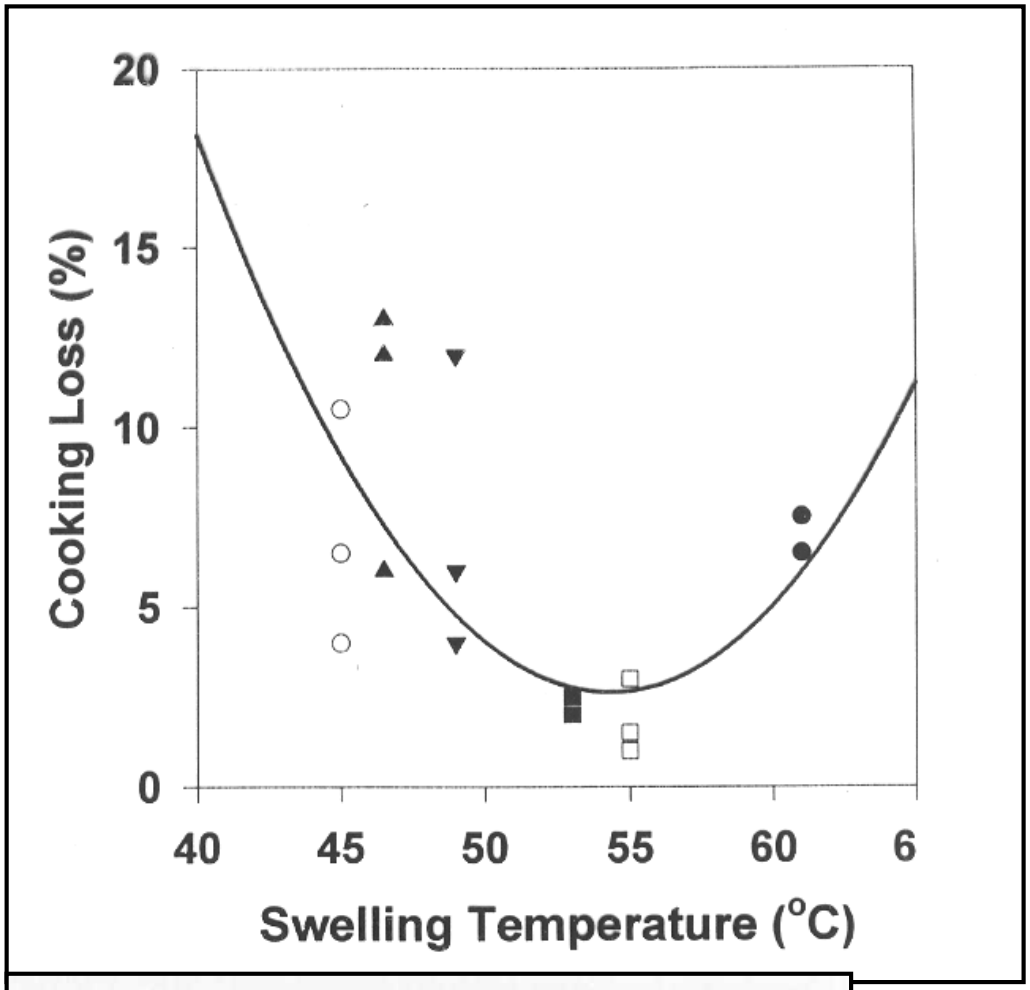
The viscosity of the starch slurry



The swelling of potato starch in the microscope, when heated from 25 to 70°C.



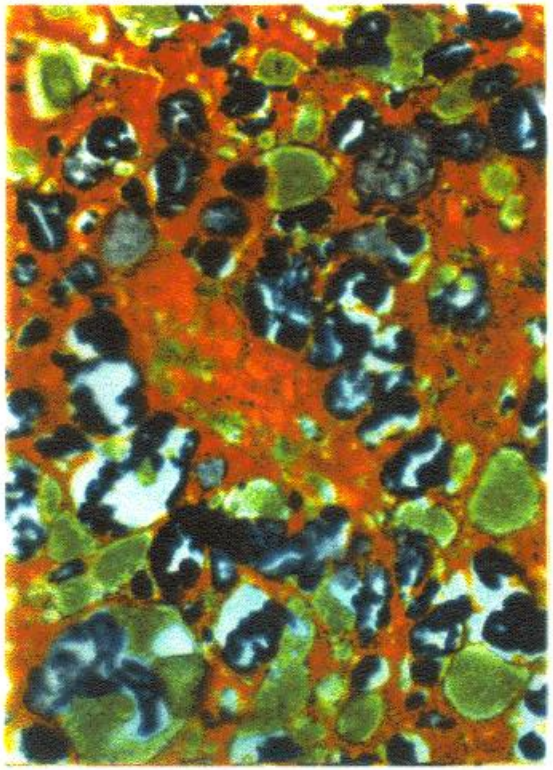
Comparing starches having different swelling temperatures with regard to cooking loss in sausages



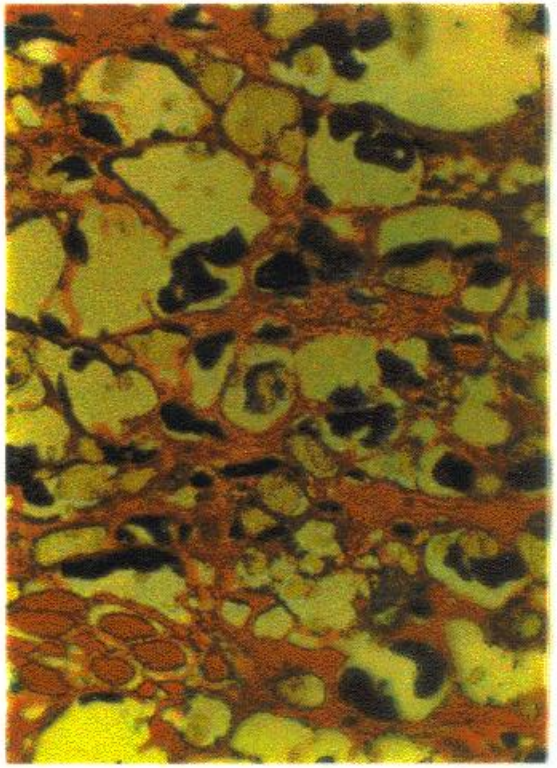
*Cooking losses in sausage batters when heated to 75°C, as a function of the starting temperature for gelatinization (judged using light microscopy) of different starches: (2:□) native potato starch, modified potato starches (3:▼, 4:▲ and 5:○) and amylopectin starches from barley (6:●) and potato (7:■). (r=0.67**)*

It is optimal to add a starch that start to gelatinise at 55°C, which is the case for both native and amylopectin potato starch.

From Tornberg,E., Andersson,K. and Asplund,I. The Mechanism of Functionality of Potato Starch in Meat Products. Gums and Stabilisers for the Food Industry 9. Eds.P.A.Williams and G.O. Phillips Roy.Soc. of Chem.p.295,1998.



Fresh sausage with added potato starch



Frozen and thawed sausage with added potato starch

Conclusions

• Additives like **salt, nitrite and polyphosphate** in meat products are considered **not to be healthy** although the evidence for that is not convincing. However, **salt** is very important for **taste and texture** and **nitrite** is crucial for **safety and color** of the products. **Polyphosphate** can act as both an **antioxidant and a water binder.**

• **Antioxidants** are very important in meat products as they can **increase the quality** of the meat products with regard to **health, color, flavor, texture and water holding.**

• **Dietary fibers** can exchange fat in meat products, but it is very dependent on the type of fiber added and also on the type of meat product.

• **Native Potato starch** is an excellent additive to meat products as it start to swell at about 55°C, where the meat start to loose its water, which is then taken up by the swelling potato starch granules. However, native potato starch is sensitive to freezing.