

Fishmeal for FEED – Physical quality effects

NORDIC CENTRE OF EXCELLENCE NETWORK IN FISHMEAL AND FISH OIL

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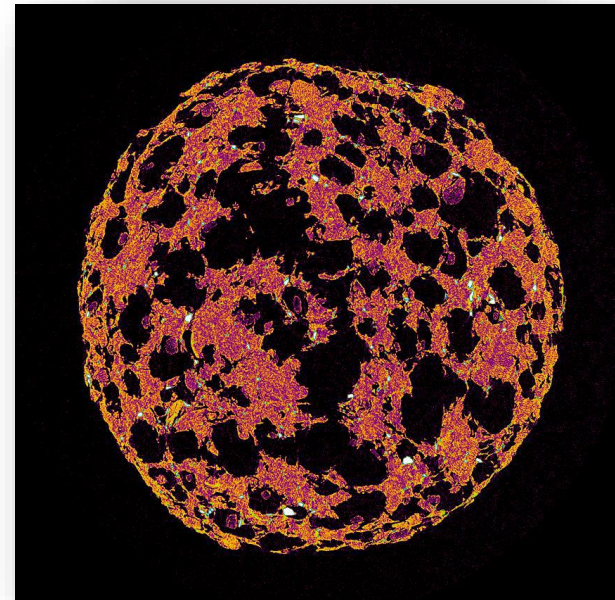
Presentation outline

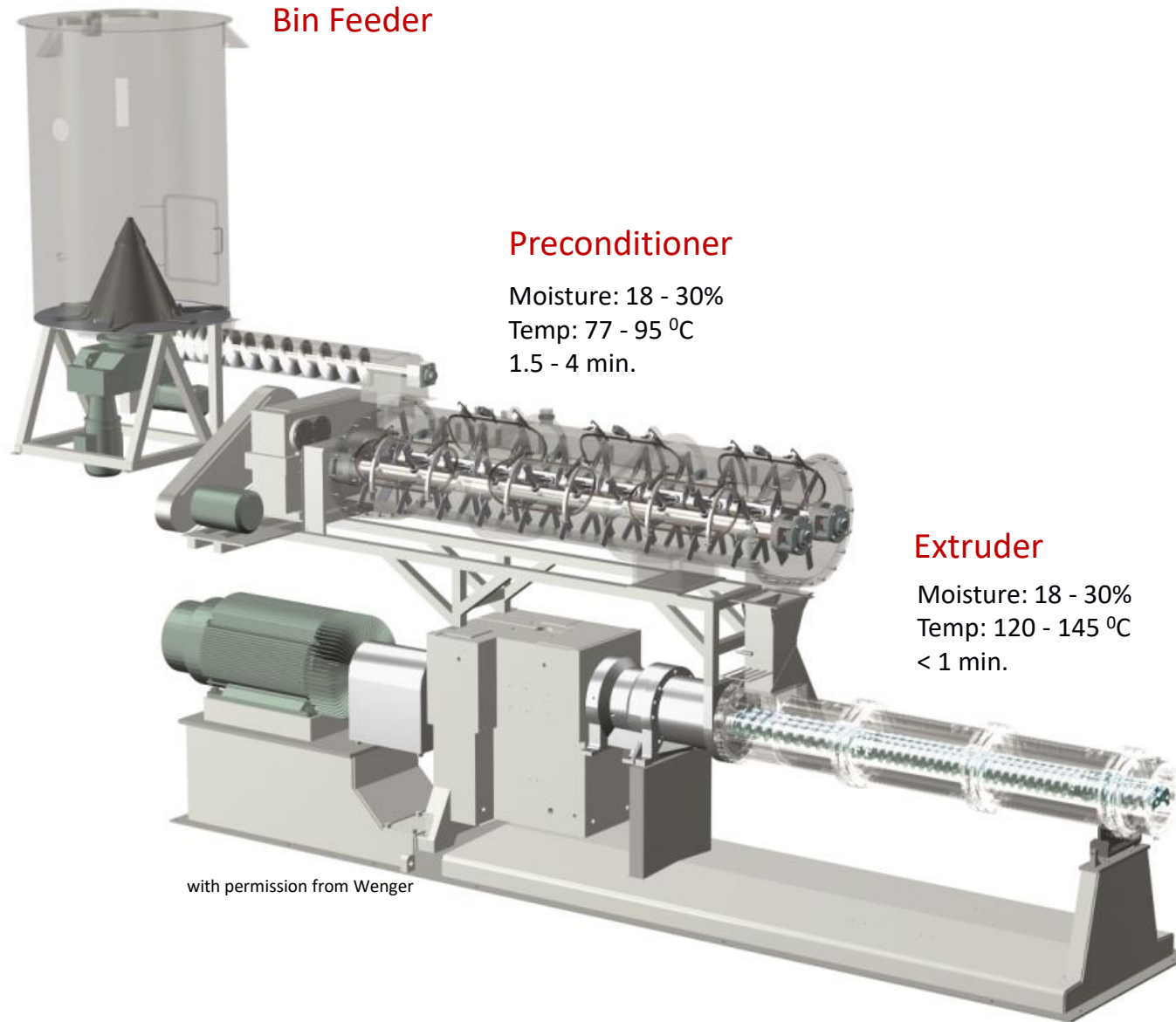
- Extrusion processing and biopolymer transformation
- Plasticizer
- Impact of ingredients on physical feed quality
- Plasticization effect of water-solubles and amino acids
- Conclusions

Extrusion

Extrusion processing is a technology that enables the production of high quality feed

- Balanced for optimal feed intake and feed utilization
- High physical quality to minimize product loss
- Water stable to minimize degradation
- Expanded to adsorb desired amount of oil but dense enough to sink
- Optimal microstructure to minimize oil leakage





Bin Feeder

Preconditioner

Moisture: 18 - 30%
Temp: 77 - 95 °C
1.5 - 4 min.

Extruder

Moisture: 18 - 30%
Temp: 120 - 145 °C
< 1 min.

with permission from Wenger

Moistening
Heating
Kneading
Cooking
Texturizing

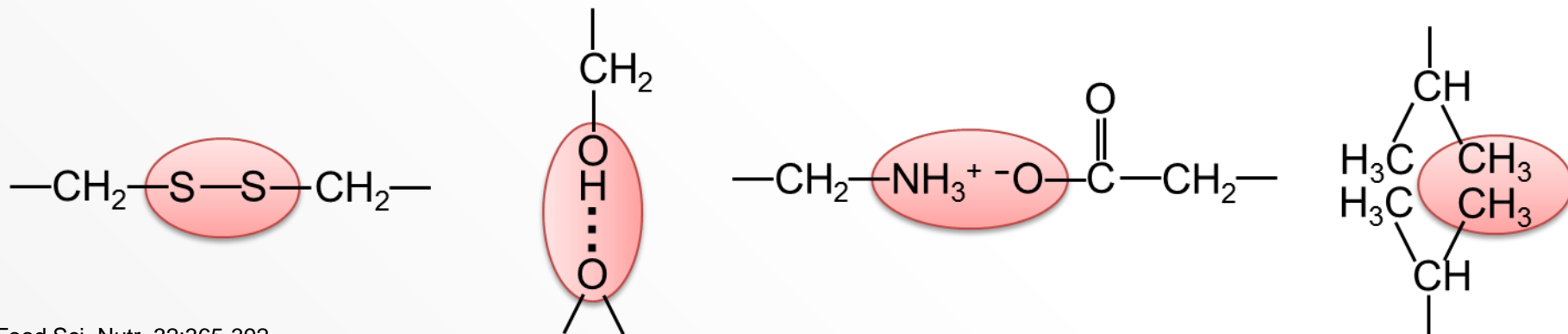
thereafter cut into extrudate pieces, dried and coated with lipids

Biopolymer transformation in the extruder



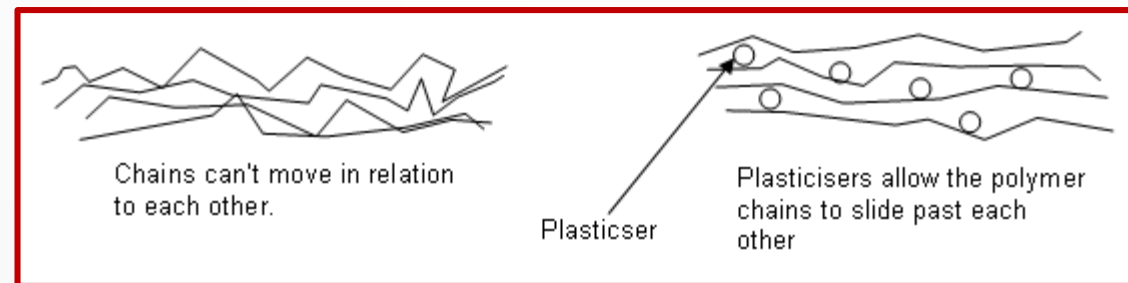
Step 1: Open up the powdery structure

Step 2: Create new intermolecular binding networks



Why add water to the process?

- Energy (heat) and water is needed for the transformation from powder to a high viscous melt in the extruder
- Water reduces the energy needed for this transformation
- Water is called a plasticizer
- Other low molecular components can also act as plasticizers



<http://www.4college.co.uk/a/dp/polymers.php>

How to measure the plasticization effect?

Glass transition

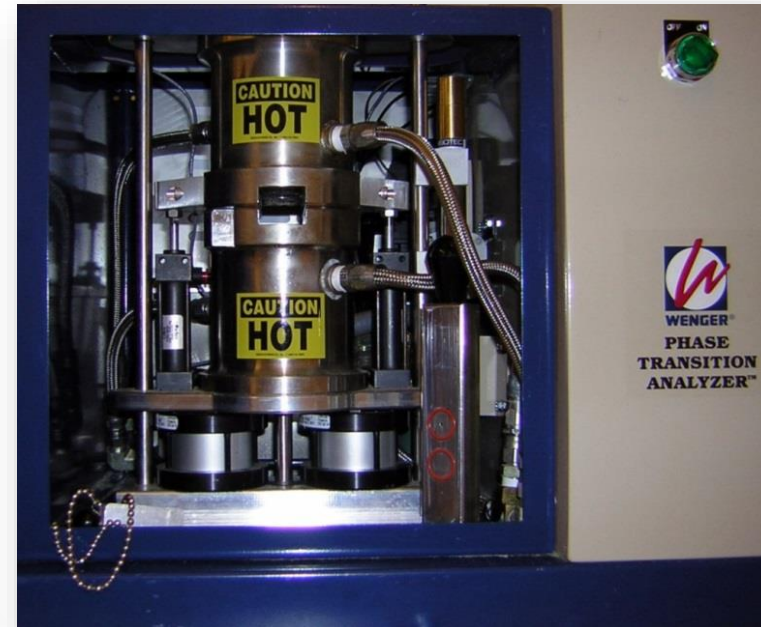
- a temperature where the biopolymer transits from a brittle glassy to a soft rubbery state
- glass transition temperature (T_g)

Flow-starting

- a state where the biopolymer can be considered as a highly viscous melt or fluid (start to flow)
- flow-starting temperature (T_f)

Phase Transition Analyzer

- closed-chamber capillary rheometer
- measure T_g and T_f of a biopolymer



Wenger Manufacturing, Sabetha, KS, USA

Plasticizer

- reduces both T_g and T_f of a biopolymer

Impact of ingredients on physical feed quality

Two high quality fishmeal, A and B

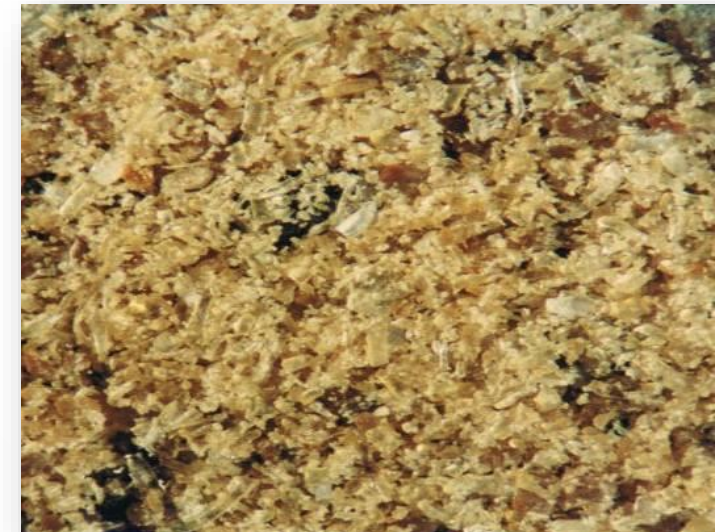
	A	B
Protein (%)	75,9	75,2
Water (%)	7,1	8,4
Ash (%)	9,9	8,7
Fat (%)	9,4	8,8

Fishmeal 74 %

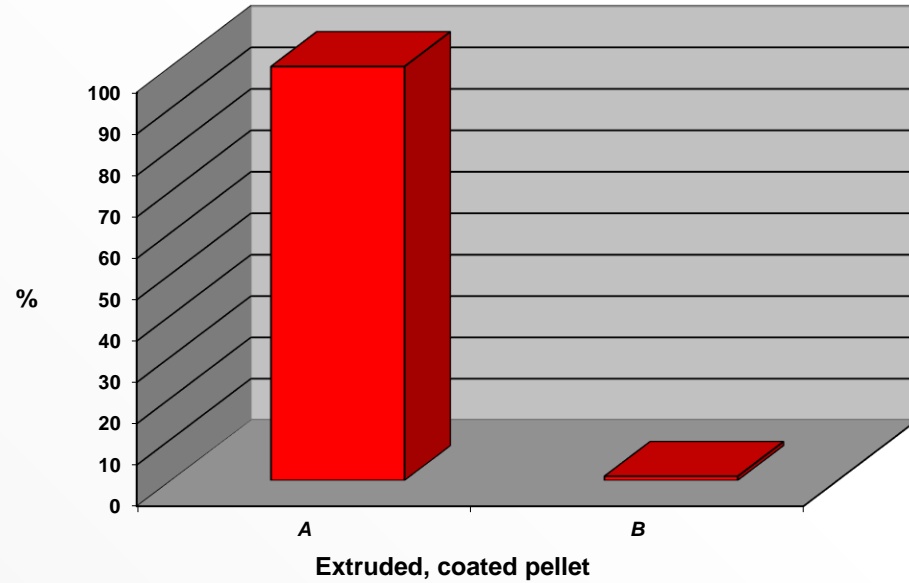
Whole wheat flour 20 %

+ fish oil, vitamin- and mineral mix and astaxanthin

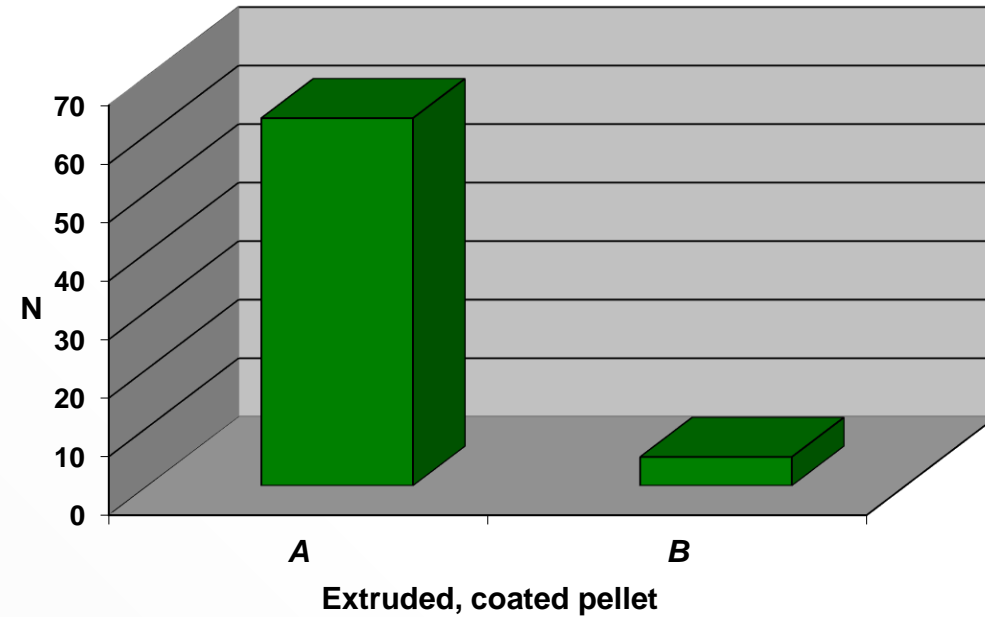
Same diet composition and standardised extrusion conditions



Pneumatic durability



Hardness



Fishmeal from herring:

Water-soluble protein

A: 26 g/100g protein

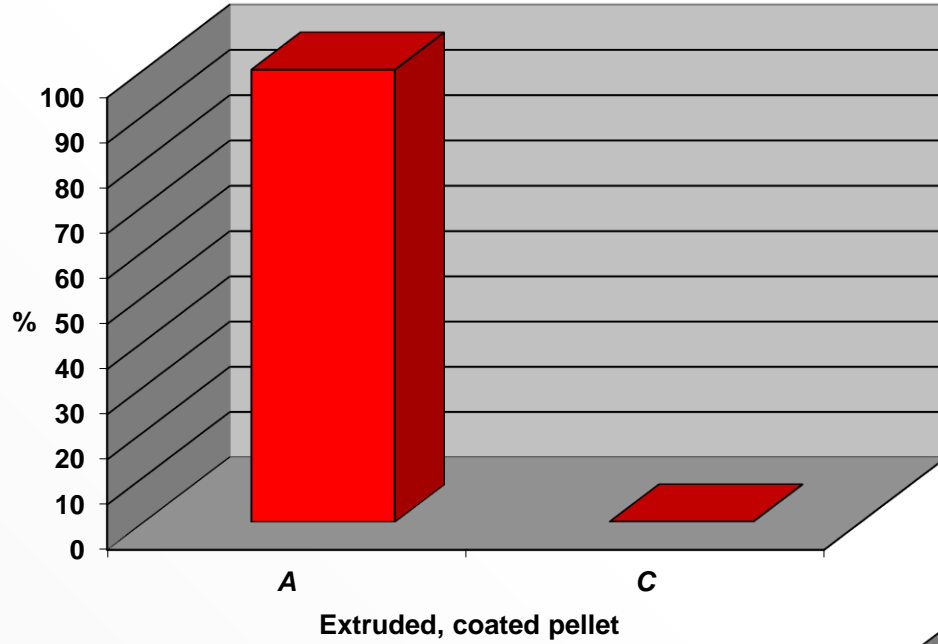
B: 15 g/100g protein

Two high quality fishmeal, A and C

	A	C
Protein (%)	75.9	74.9
Water-soluble protein (%)	26.3	26.1
Water (%)	7.1	7.7
Ash (%)	9.9	10.8
Fat (%)	9.4	8.0



Pneumatic durability



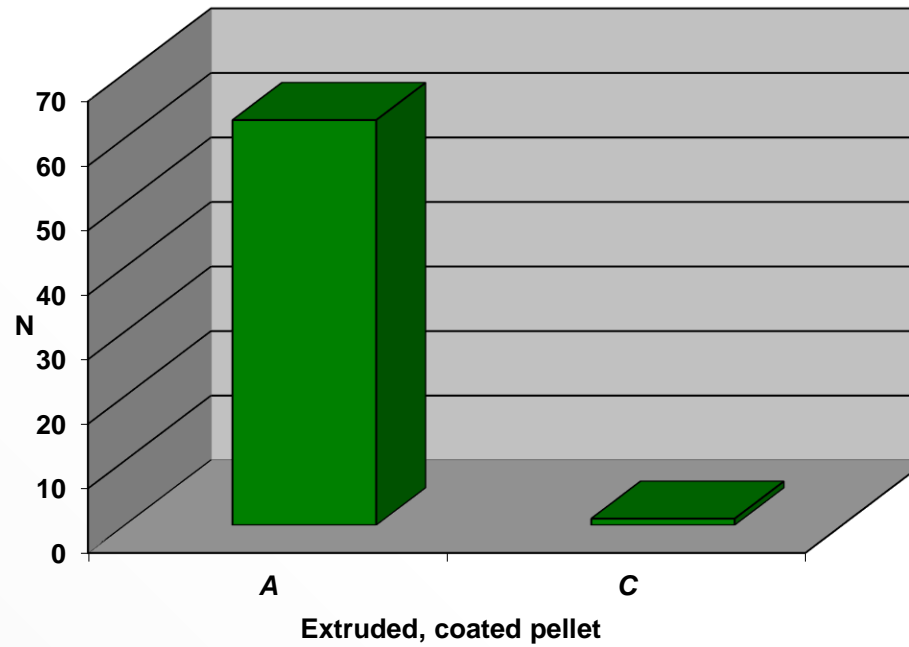
Fishmeal from different species:
A: Herring



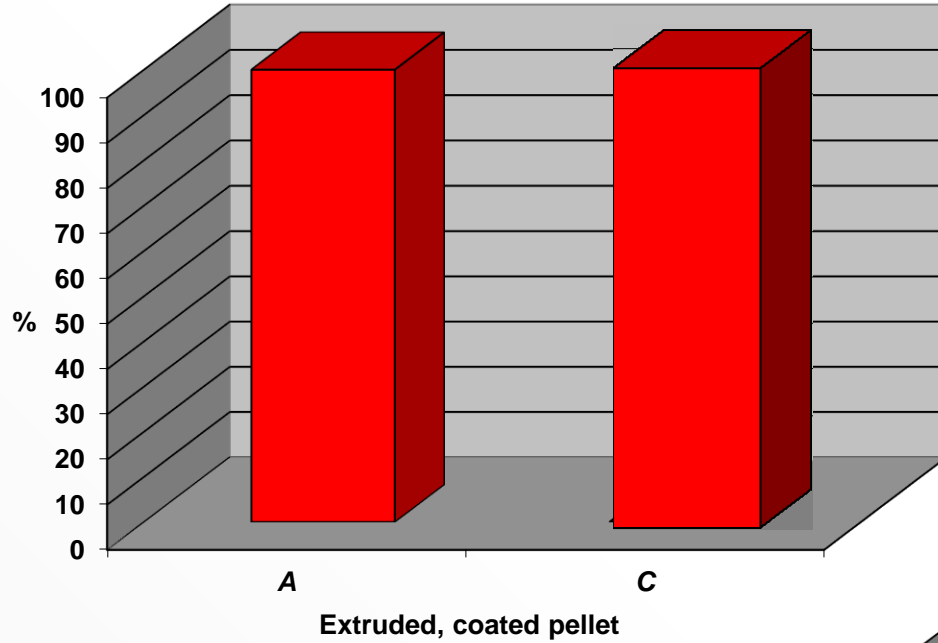
C: Sand eel



Hardness



Pneumatic durability



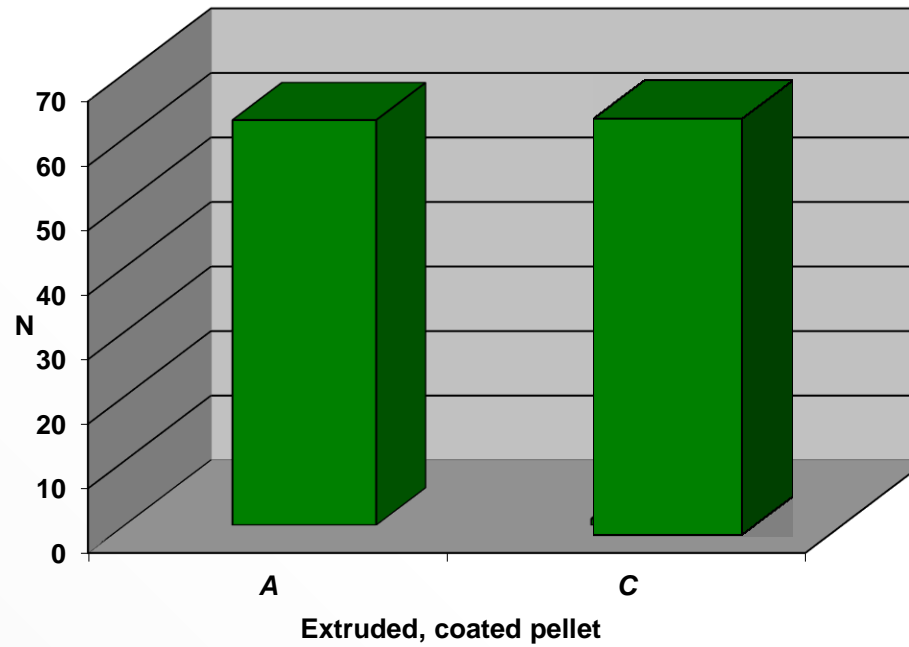
Low shear:



High shear:



Hardness



Fishmeal from different species:

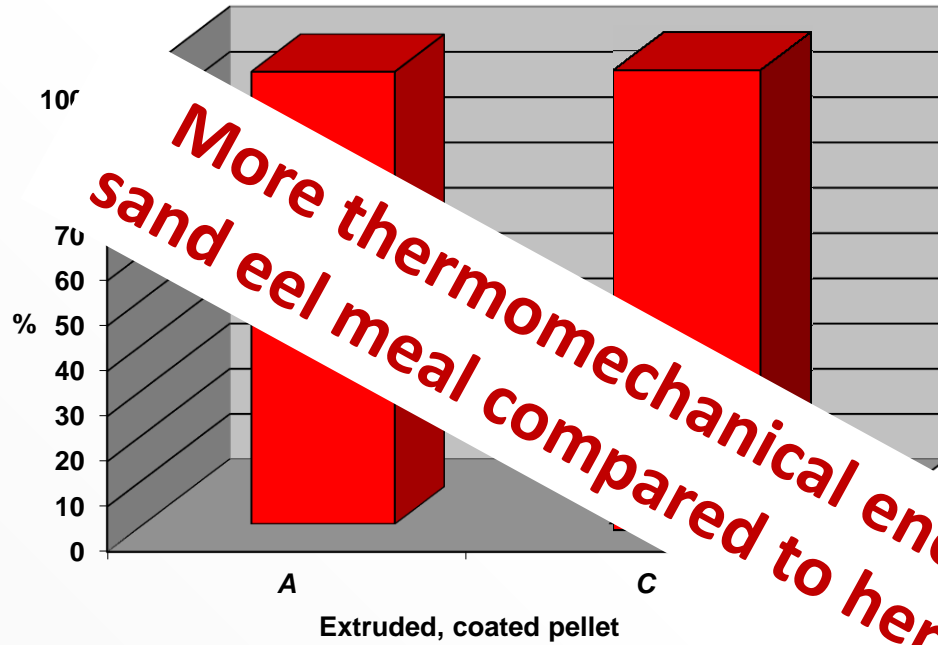
A: Herring



C: Sand eel



Pneumatic durability



Low shear:



High shear:



More thermomechanical energy is needed to transform sand eel meal compared to herring meal based feed mixes

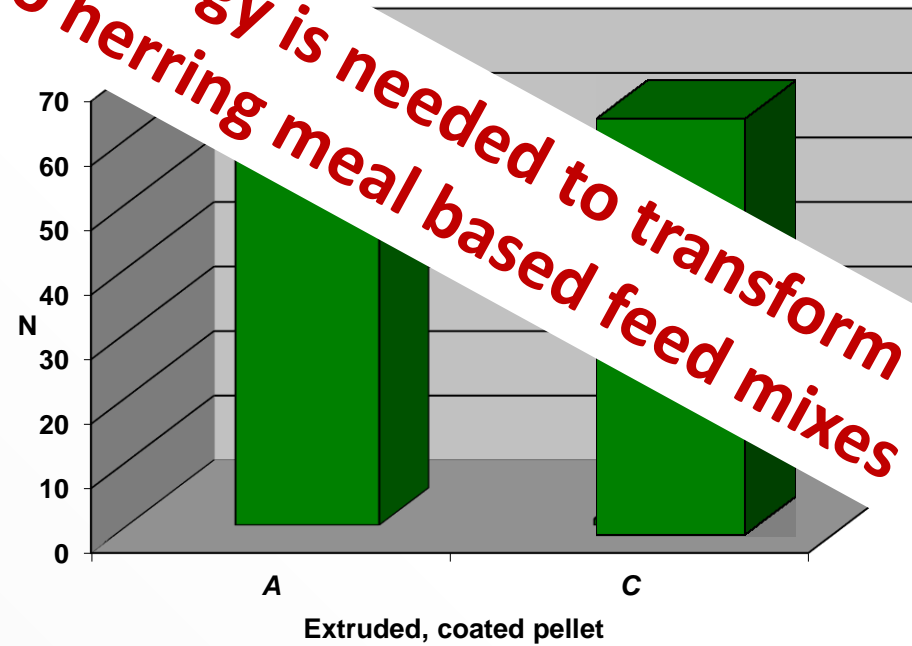
Fishmeal from different species:
A: Herring



C: Sand eel



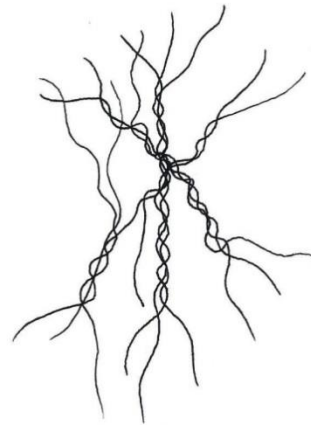
Hardness



Water-soluble protein increase physical pellet quality:

- Long-chain water-soluble proteins

→ Gelatine



Large amount in:

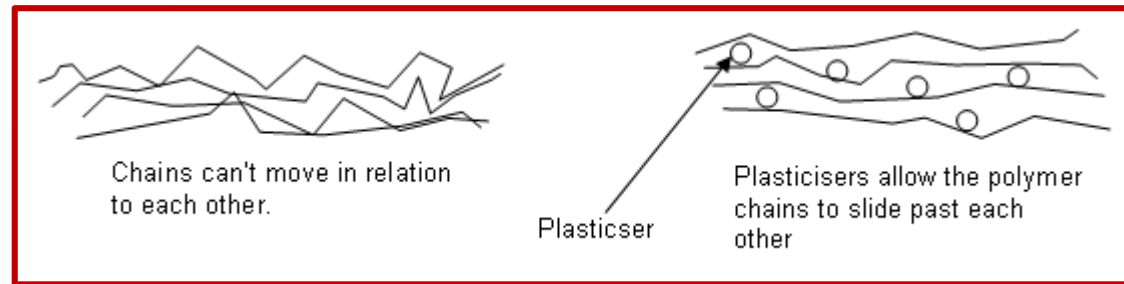


Small amount in:



Water-soluble protein increase physical pellet quality:

- Amino acids and small peptides act as plasticizers similar to water



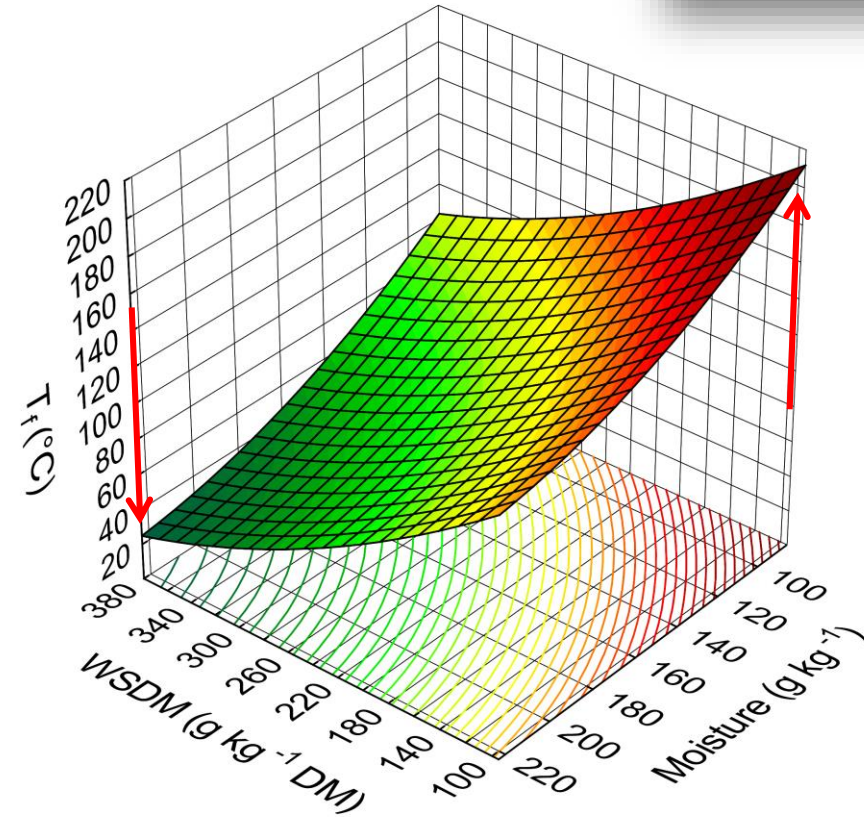
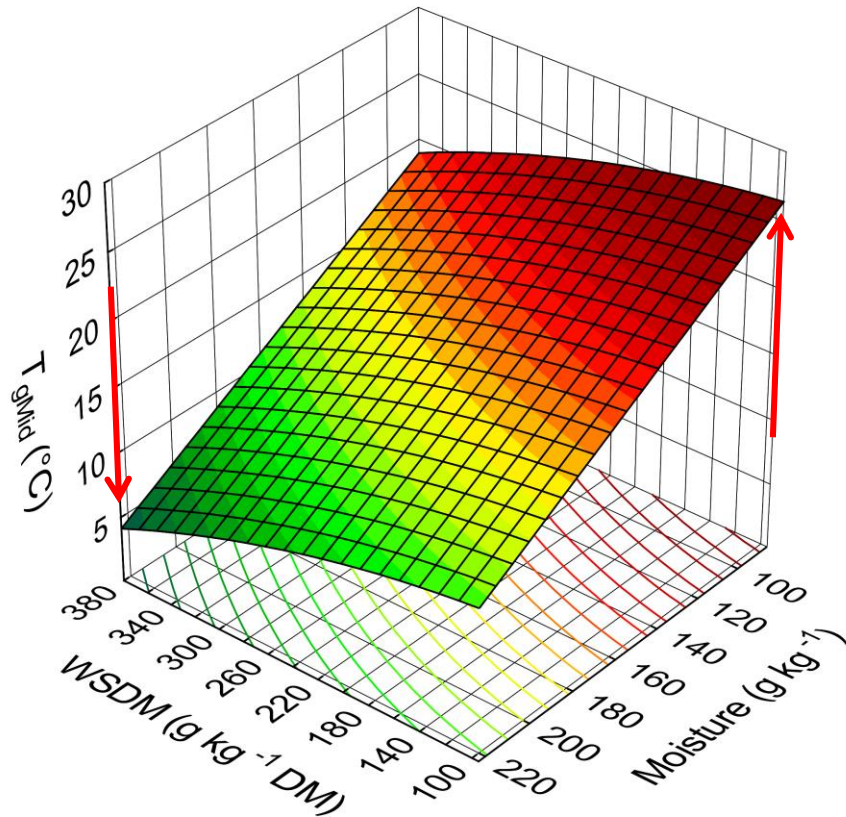
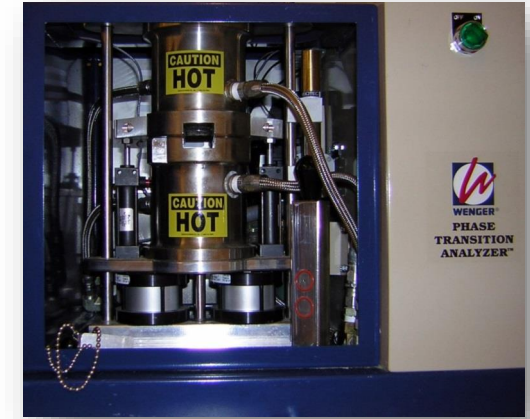
<http://www.4college.co.uk/a/dp/polymers.php>

Compared to water also increase melt viscosity and cooking efficiency

Plasticization effect of solubles in fishmeal

A central composite design

- variables: moisture and water-soluble protein
- responses: glass transition (T_g) and flow-starting temperature (T_f)



Small particles with fibrous structure increase physical pellet quality:

- High level increase extruder specific mechanical energy (viscosity) and cooking efficiency due to increased particle to particle contact area and higher friction and easier to hydrate



Fishmeal has unique technical properties which differs extensively from plant-based protein ingredients

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Contents lists available at ScienceDirect

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journal homepage: www.elsevier.com/locate/anifeedsci



Assessment of the effects of fish meal, wheat gluten, soy protein concentrate and feed moisture on extruder system parameters and the technical quality of fish feed

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Compared to fish meal, soy protein concentrate (SPC) are generally:

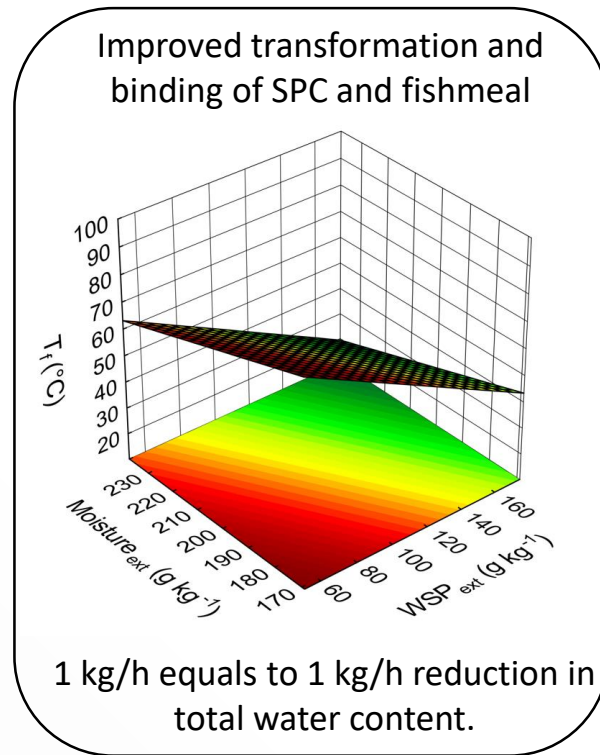
- low in water-soluble proteins
 - less plasticizing effect
- low in lipids (FM ~10% lipids, SPC ~1% lipids)
 - higher viscosity/shear and energy input
- higher water input
 - increased energy input for production and drying

Is it possible to plasticize SPC with water-solubles or amino acids?

yes

Ahmad et al. 2018. Int. J. Food Sci. Technol. 6:1425-1433.

Low molecular weight water-soluble proteins, fish silage and protein hydrolysates



Replacement of water in the extrusion process will reduce extrudate moisture content, drying costs and feed loss


An additive with triple benefits

nutrient, plasticizer and binder in extruded fish feed

Research challenges

An additive with triple benefits

- Can this information be used to develop a higher value fishmeal product that can act as a nutrient, plasticizer and binder in extruded fish feed?

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Thank you for your attention!



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