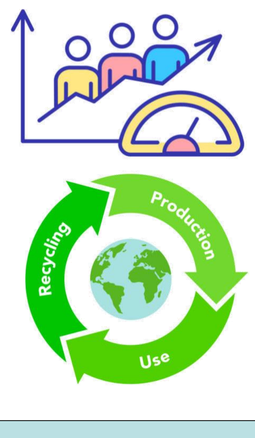
Characterization of the gelling properties of protein from bovine co-products using response surface methodology

Rozenn Le Foll[a], Valérie Lechevalier[a], Catherine Guérin[a], Amélie Deglaire[a], Xavier Lambert[b], Françoise Nau[a].

a UMR STLO 1253, INRAE, INSTITUT AGRO RENNES-ANGERS, 65 rue de Saint-Brieuc, 35042 Rennes cedex, France
b CORNILLE sas, Cornillé, 35500, France

DOCTORAT ECOLOGIE BRETAGNE GEOSCIENCES LOIRE AGRONOMIE ALIMENTATION

Context



Growing food needs linked to global demographic change are driving:

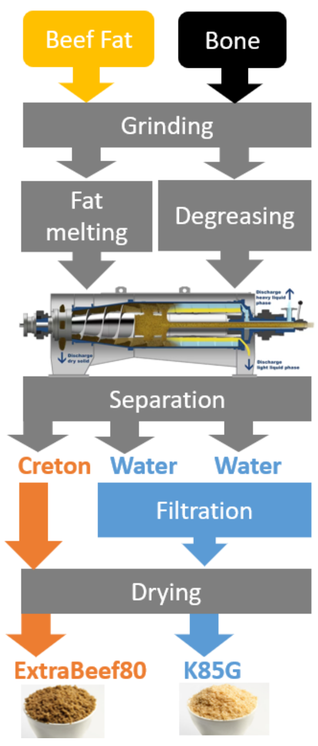
- Nutritional issues: Availability of high quality protein resources
- Environmental issues : Sustainable solutions to meet this growing demand for protein resources

Edible meat co-products are underutilized in the human diet; valorize co-products:

- Would increase the protein resources of good nutritional quality
- Would reduce the quantity of wastes
- Would contribute to a more sustainable and more profitable meat industry

Materials and Methods

Manufacturing process



(Patent: EP 2 108 266 A1)

Gel making



+ *Water*

Solubilization

Modulation:
- pH (4 to 7)
- ionic strength (0 to 0.4M NaCl)
- Protein concentration (5 to 20%)



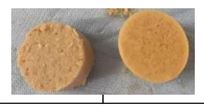
Thermomix®

- 1 min max speed (9)
- 30 min speed 3 at 90°C or 50°C
- 1 min max speed (9)

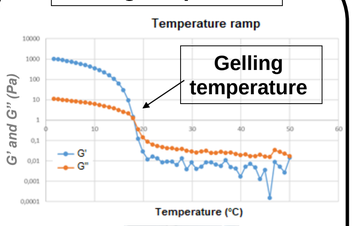
Cooling at 4°C (72H)

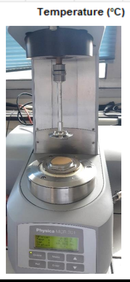


Gelling properties



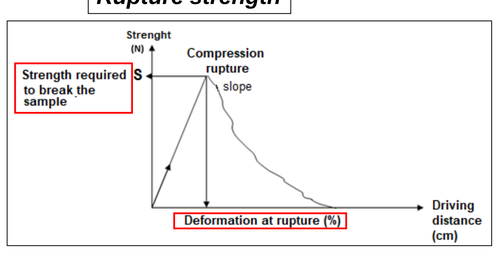
Gelling temperature

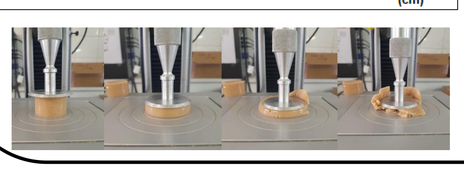




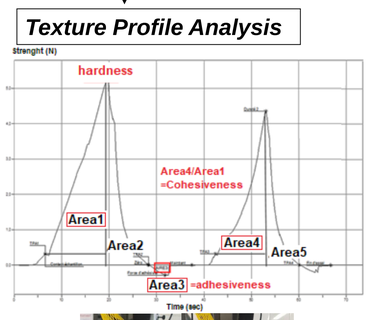
Texture

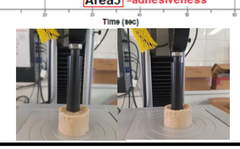
Rupture strength



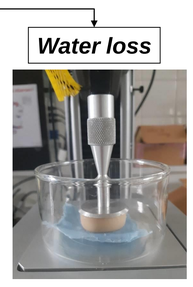


Texture Profile Analysis





Water loss



$$W\,(\%) = \frac{M_0 - M_1}{M_0} \times 100$$

M0 *the water content of the cylindrical gel (g) before compression.*
M1 *the water content of the cylindrical gel (g) after compression.*

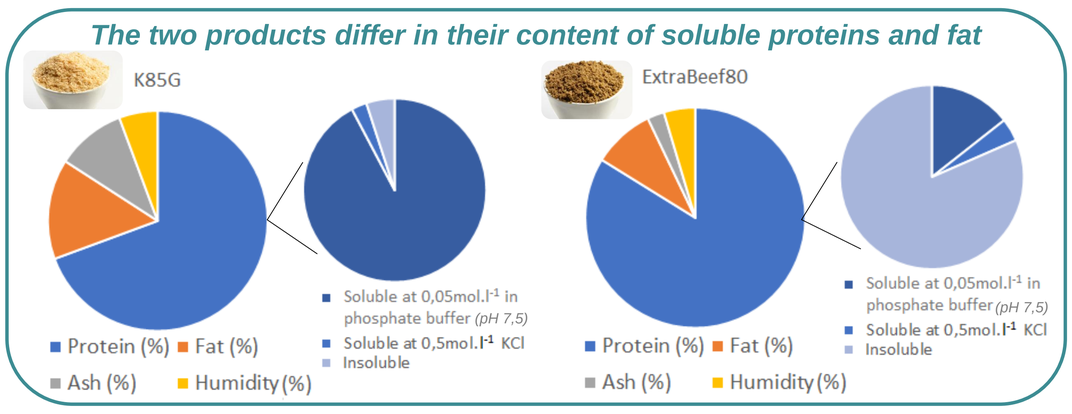
Response surface methodology : Central composite design

- Experimental variables : protein concentration, pH and ionic strength (Xi)
- Adjusted to a second-degree polynomial regression model

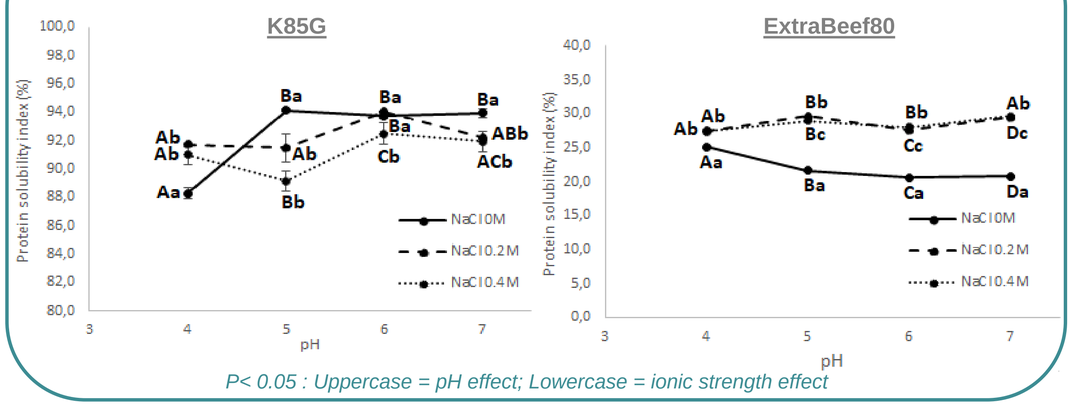
$$Y = \beta_0 + \sum_{i=1}^{3} \beta_i X_i + \sum_{i=1}^{3} \beta_{ii} X_i^2 \sum_{i,j=1}^{3} \beta_{ij} X_{ij}$$

Results

The two products differ in their content of soluble proteins and fat

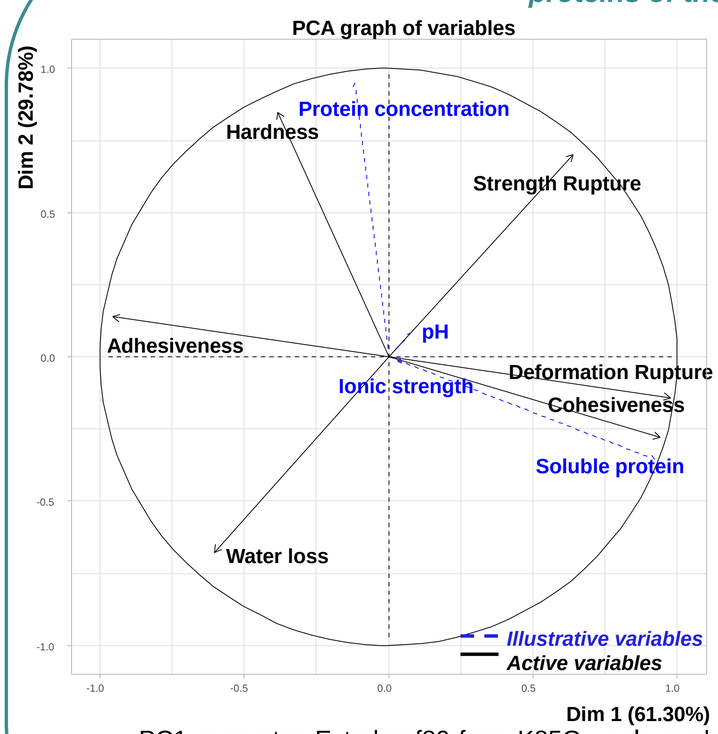


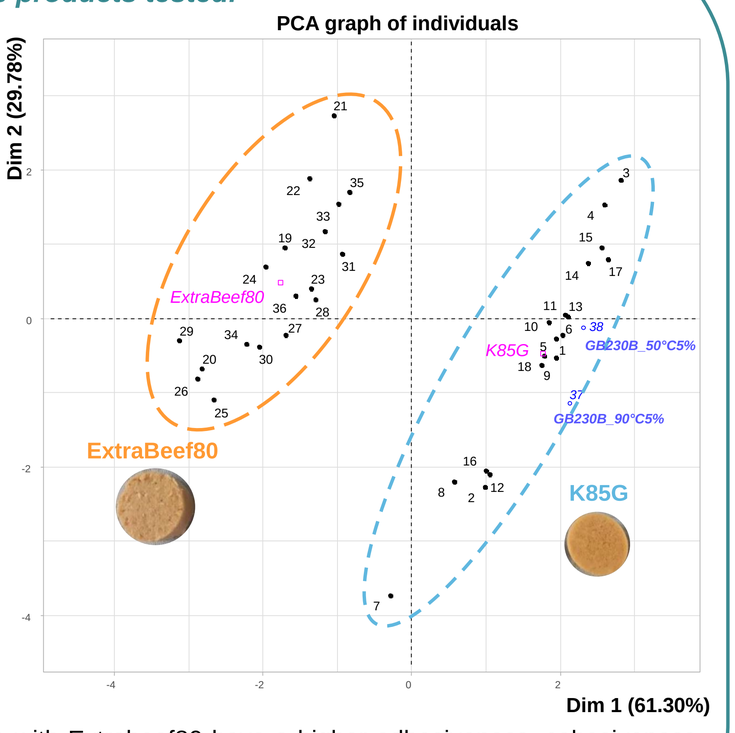
K85G protein solubility is higher but more sensitive to pH than ExtraBeef80's one



P< 0.05 : Uppercase = pH effect; Lowercase = ionic strength effect

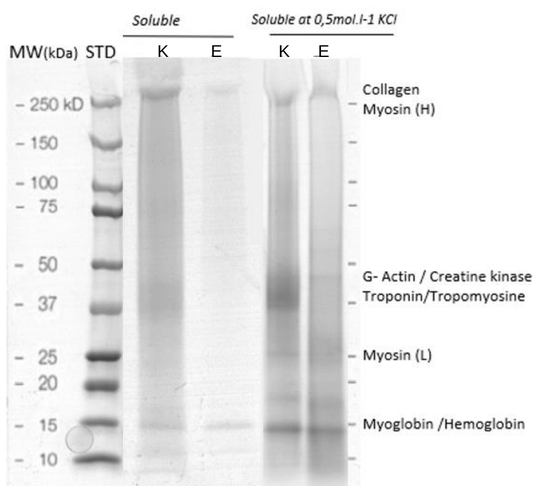
The gelling properties depend mainly on the concentration of proteins, especially soluble proteins of the products tested.





- PC1 separates Extrabeef80 from K85G : gels made with Extrabeef80 have a higher adhesiveness, cohesiveness and deformation at the rupture than K85G gels. PC1 is well correlated with soluble protein concentration.
- PC2 explains the variability within gels from a given product opposing hard gels with low water loss (top) to soft gels with high water lost (bottom). PC2 is well correlated with protein concentration.
- K85G best mimics commercial gelatins at 230Bloom (GB).

Soluble protein fractions are mainly composed of sarcoplasmic proteins, myofibrillar proteins and collagen, known for their gelling properties.

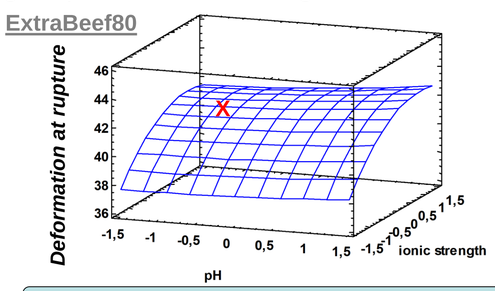


What about the effect of pH and ionic strength?

The gelling properties of K85G are not influenced by pH and ionic strength contrary to ExtraBeef80 gels :
- Increasing the ionic strength increases the deformation at the rupture and decreases the water loss of ExtraBeef80 gels.
- Increasing pH decreases the water loss of ExtraBeef80 gels.

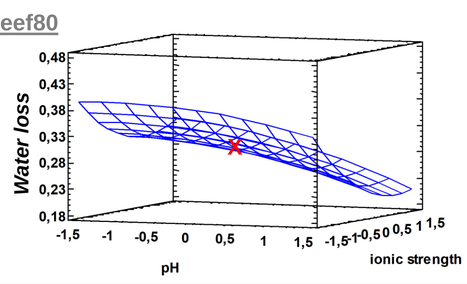
Modulating the pH and/or Ionic strength allows ExtraBeef80 to approach the properties of commercial gelatin.

ExtraBeef80



pH = 4.61; I = 0.27M NaCl ; protein concentration = 20%

ExtraBeef80



pH = 5.72; I = 0.23M NaCl; protein concentration = 14.05%

X Optimal conditions to mimic a commercial beef gelatin 230Bloom (5% protein, pH=5.55, 0.2M NaCl)

Conclusion

- **The protein concentration is the key factor in optimizing the gelling properties of both beef co-products.**
- **K85G gelation does not depend on pH or Ionic strength and comes closest to commercial gelatin than ExtraBeef80.**
- **The variations in pH and Ionic strength on the Extrabeef80 make it possible to approximate the gelling parameters of commercial beef gelatin.**
- **These results may be useful in guiding the development of functional ingredients suitable for specific technological uses.**