Improve Cheddar cheese Yield with Transglutaminase

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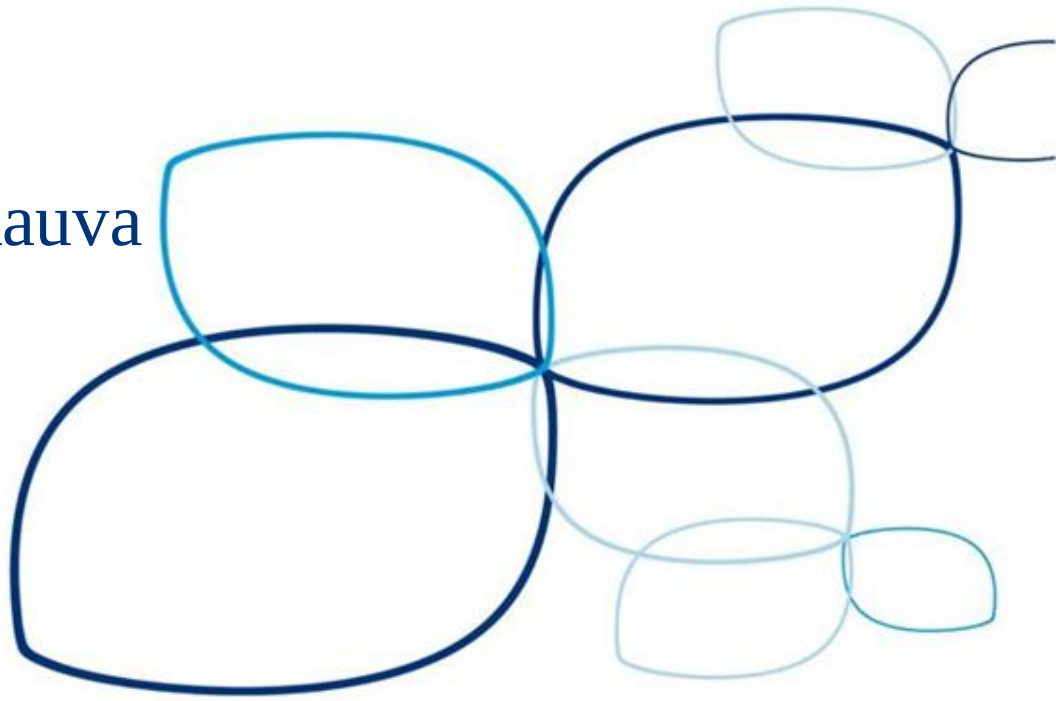

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Introduction

TRANSGLUTAMINASE

- Transglutaminase (TG) is enzyme which crosslinks proteins
  - Forms covalent links between lysine and glutamine
  - Has been used in food industry to
    - Improve yield
    - Production of different gels without additives
- In milk
  - TG cross-links
    - κ-, β- and α_s- caseins
      - links are formed inside and between the casein micelles
    - β-lactoglobulin and α-lactalbumin only at denatured (unfolded) forms
    - Tg inhibitor: size of lactose, but not identified yet

Introduction

TRANSGLUTAMINASE IN CHEESE-MAKING

- Possibility to increase cheese yield
  - Higher water binding without cheese softening
  - CMP binding
- Historical problems
  - Excessive cross-linking of casein micelles
    - Increase coagulation time (coagulation problems)
  - Active TG-enzyme during ripening
    - Cross-linking continues → Texture problems (rubbery)
  - Active TG in whey

→TG treatment has to be full controlled

→ TG inactivation is essential before cheese-making

  - Especially in cheese with long self life (ripened cheeses)

Introduction

- Previously it has been shown that with protein standardization TG can be used in a controlled manner
  - TG is active in retentate
  - TG will be inactivated during cheese milk making
    → Increase of TG inhibitor
- It was observed that edam type cheese
  - yield increased 4 %
  - No effect to the structural or organoleptic properties was found
- What about whey fraction
  - Previously it has been shown that TG activity or protein can not be found in whey fraction
    - Small dosage to milk
    - No difference in protein profiles of control and TG whey
  - TG enzyme has Halal and Kosher certificates

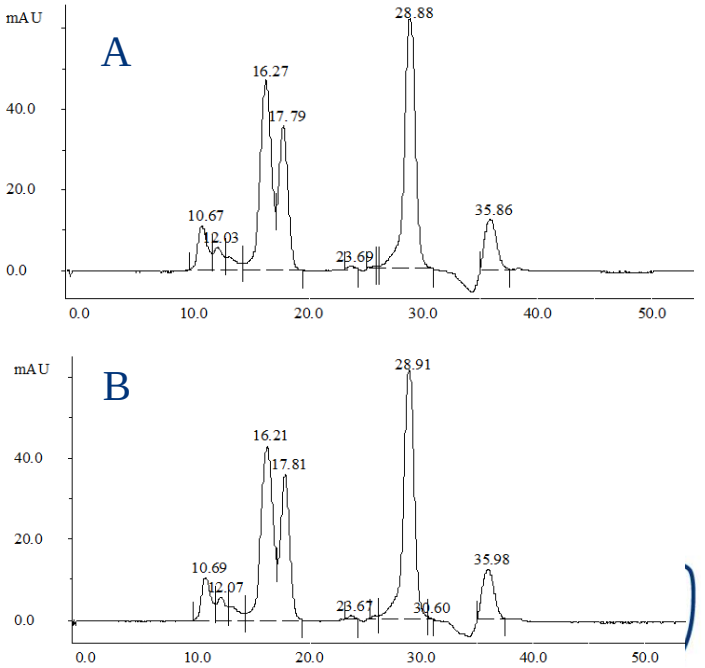


Fig. 1. Protein profiles from (A) Control whey and (B) TG whey

Aims of this study

Test the effect of TG on Cheddar cheese yield and quality

- Protein standardization with TG treatment
  - After concentration
    - High substrate concentration
    - Inhibitor removal during protein concentration
  - After standardization
    - Dilution during standardization
    - Inhibitor addition during standardization
- Addition of TG in liquid form to improve homogeneity
- Evaluation of cheddar cheese yield and component recoveries
- Evaluation of cheese quality made with TG

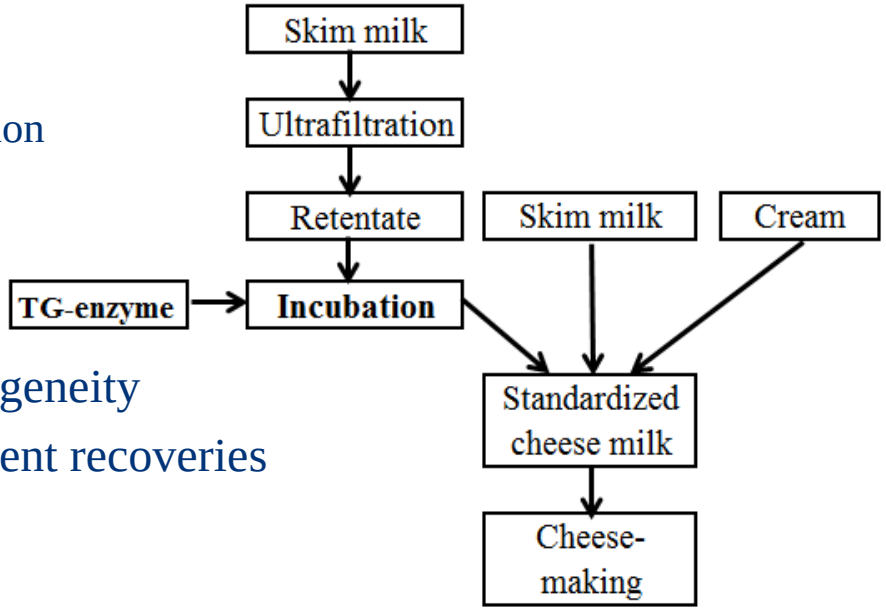


Fig. 1. TG treatment of cheese milk in protein standardization process

Materials and methods

- Cheddar cheese production
  - Cheese milk was standardized
    - TG was added to retentate before standardization steps
    - Control cheese was produced without TG addition
  - Cheese was produced as traditional Cheddar
    - Including:
      - Cooking
      - Cheddaring
      - Milling
      - Dry salting
- Cheese yield
  - and recovery of components
- Quality evaluation
  - Sensory test: Profile analysis
  - Textural analysis

Results

- Milk consumption reduced when TG was used compared to control cheese
  - 0,4l/kg cheese was the saving of milk
- Yield increase was mainly water binding
  - Only moisture increase was statistical significant
- In cheese composition TG
  - reduced protein and fat content
  - increased moisture content
  - salt was added according to milk amount
    → Lower salt content in TG cheese
- In textural analyses
  - No significant differences were found

Table 1. Cheese yield and milk consumption in control and TG cheese-making

Cheese	Milk (l)	Cheese (kg)	Cheese yield (%)	Milk consumption (l/kg)
Control	920	113,1	12,3	8,1
TG	1000	129,6	13,0	7,7

Table 2. Component recoveries from milk to cheese

Cheese	Protein (%)	Fat (%)	Total solids (%)	Moisture (%)
Control	84	96	59	4,8
TG	86	100	61	5,2
Increase (%)	2,3	4,0	2,4	9,4

Table 3. Fat, total solids, moister in fat free base (MFFB) and salt contents of TG and control cheeses

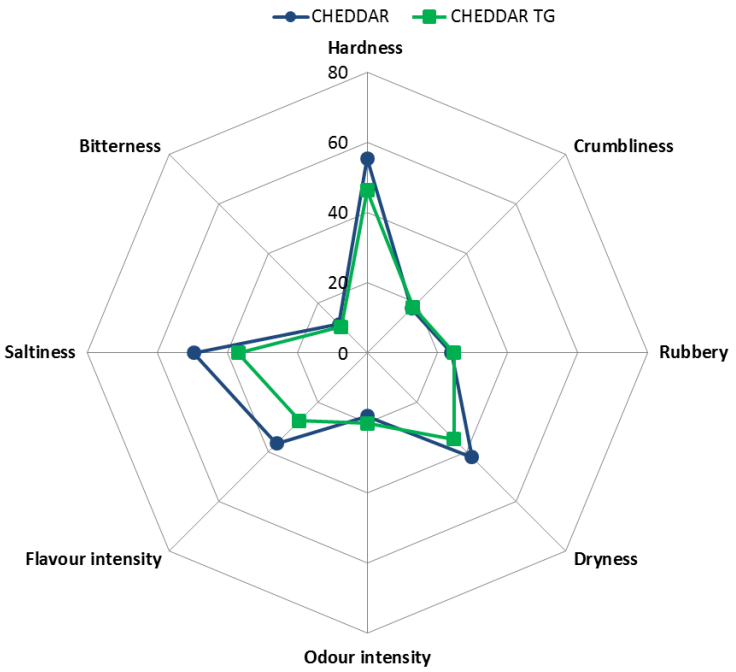
Cheese	Protein (%)	Fat (%)	Salt (%)	Total solids (%)	MFFB (%)
Control	27,0	34,7	1,8	66,2	51,8
TG	26,0	34,0	1,5	65,0	53,0

Table 4. In textural analysis, there was not significant differences between TG and control cheeses.

Cheese	Age	Hardness (kg)	Cohesiveness	Elasticity
Control	3 months	$16,0 \pm 1,4^{a}$	$0,27 \pm 0,02^{a}$	$0,311 \pm 0,008^{a}$
TG	3 months	$16,3 \pm 0,8^{a}$	$0,25 \pm 0,01^{a}$	$0,307 \pm 0,005^{a}$
Control	6 months	$17,4 \pm 2,0^{a}$	$0,25 \pm 0,01^{a}$	$0,310 \pm 0,010^{a}$
TG	6 months	$14,5 \pm 0,8^{a}$	$0,25 \pm 0,01^{a}$	$0,309 \pm 0,006^{a}$

Results

- Organoleptic analysis was done for cheddar cheeses in age of 3 months
- Saltiness of control cheese was higher than in TG cheeses
  - → This was a consequence of a lower salt content
  - Another differences were not found in TG and control cheeses



Discussion

- TG increases cheese yield
  - Less milk is needed to cheese production

  → The savings depend on the price of milk
    - 7,3 cents/kg(cheese) when the price of milk is 35 cents/l

    → 100 million kg(cheese)/year

    → Savings are **7,3 million €/year**
- Protein standardization process makes possible the use of TG
  - Benefits of protein standardization
    - Reduce product variation
    - Increase cheese making capacity
  - The price of filtration unit is ~1 million €/(100 million c.kg/year)

    →**Repayment period is less than two months**

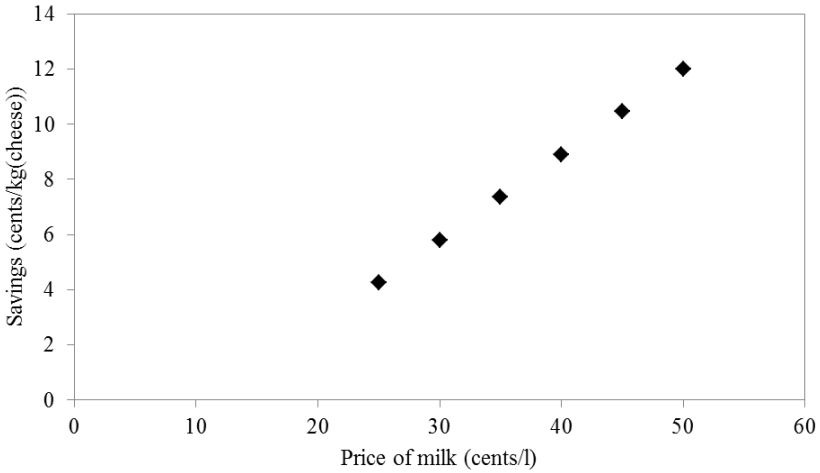


Fig. 1. Savings depend on the price of milk.

Conclusion

- TG can be used in a controlled manner in protein standardization process
  - Controlled incubation time
  - TG inactivation
  - Low dosage of TG
- TG increased cheese yield
  - Mainly increase water binding
  - No effect on organoleptic properties
- Savings depend on the price of milk
  - 7,3 cents/kg(cheese) (if the price of milk is 35 cents/l)
  - Short repayment period of protein standardization investment

Thank you!

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