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# Whey Protein Capture by Na-CMC: Opportunities for Small Dairies

Tuna Dincer<sup>1</sup>, Corinne Vallet<sup>1</sup>, Bogdan Zisu<sup>2</sup>, Mike Weeks<sup>2</sup>, Martin Palmer<sup>2</sup>, Vijay Jayasena<sup>1</sup>

<sup>1</sup> Food Science and Technology Program, School of Public Health, Curtin Health and Innovation Research Institute, Curtin University, Perth, Australia,

<sup>2</sup> Dairy Innovation Australia, Melbourne, Australia

## Current Approaches to Whey Utilisation

The major hurdles in whey utilisation from cheese production are associated with the very short shelf life and relatively high processing costs. Whey processing uses a combination of membrane processes, ion exchange separation, evaporation, crystallisation and spray drying to produce whey powders, whey protein concentrates, or isolates.

For medium to large scale manufacturers, it is feasible to invest in these technologies, but not for small and some medium scale cheese manufacturers who may still spray the whey onto land or discharge to waste streams.

**10% of the total whey is underutilised or not utilised in Australia (DIAL, 2011).**

**As a result: 20% of milk proteins in whey are lost Transport and disposal costs incur.**

Transporting whey to farms for irrigation currently costs 3 cents/L in Western Australia (2013). This is expected to increase due to increased cost of transport, the increased distances whey has to be transported and stricter environmental regulations.

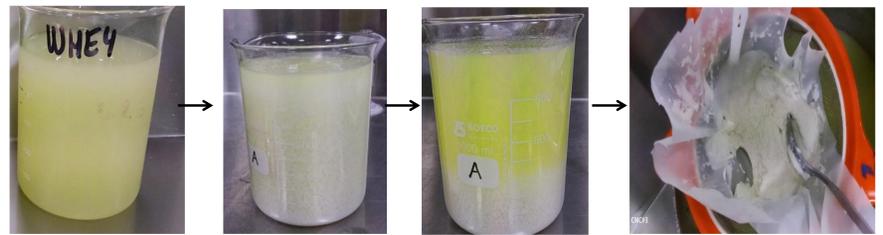
Clearly, a low cost step that can eliminate the energy intensive processes would be a significant step forward for the dairy industry toward more sustainable dairy processing. Whey concentrate/isolates produced with current methods in most of the cases are mixed with other ingredients to make a food product.

**If a food or feed grade biopolymer can be used to capture whey proteins in a simple and cost effective method, resulting whey protein-biopolymer complex could be added to feed (or food) at a reduced cost to the formulators and increased return to the processors.**

Na CMC has been reported to capture whey proteins by Hansen and Hidalgo (1971) and Hill and Zadow (1975,1978). The aim of this study was to investigate the feasibility of Na Carboxymethyl cellulose (Na CMC) to capture whey proteins with a simple process to incorporate into stockfeed or fish feed.

## Results

High viscosity Na-CMC: 0.1 % (W/W) at pH 4, dry precipitate yield of 0.7 %



Reduced  
• Turbidity  
• Volume  
• BOD  
• Protein content

46% Protein, 7% lactose, 6% moisture and 1% ash

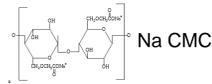
HV Na-CMC removes  $\beta$ -lactoglobulin selectively

(80%, 0.075% addition)

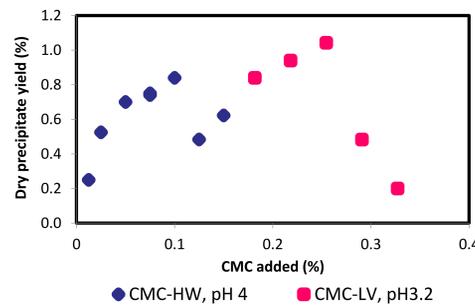
## Selectivity

## Materials and Methods

Sweet Whey, 7% TS, pH 4.99, 0.88% protein
Na CMC low viscosity (LV), 400-800cp (2%), DS 1.15-1.45, MW 250,000, Sigma Aldrich (419281)
Na CMC high viscosity (HV), 2500-6000cp (1%), DS 0.8-0.95, MW 700,000, Sigma Aldrich (419338)



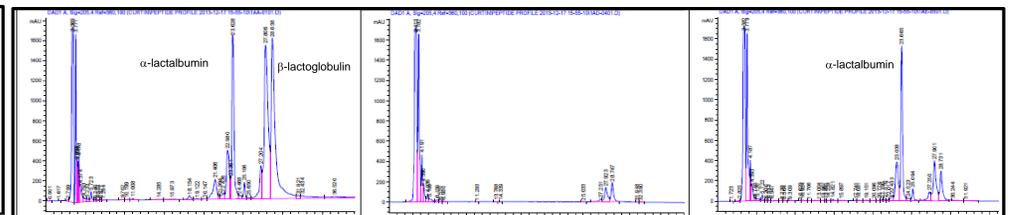
## Recovery



Whey

LV Na CMC  
pH 3.2, 0.2% addition

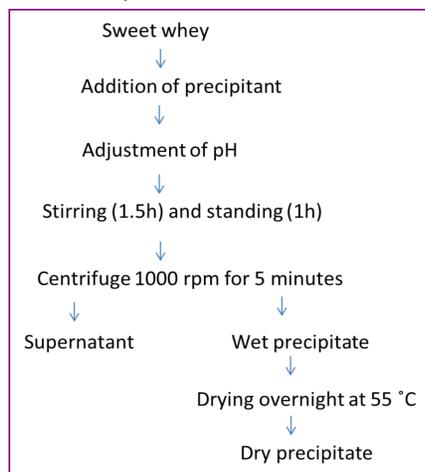
HV-Na CMC  
pH 4, 0.1% addition



## Economic Analysis

Based on 100,000 kg whey	Cost ( AU\$)	Details
<b>Current disposal method</b>	<b>Transporting whey and spraying onto land</b>	
Cost of whey disposal	2,885	\$0.029/kg
<b>Proposed disposal method</b>	<b>Recovery of 50% whey proteins, sale of fish feed, transporting whey with lower volume and BOD and spraying onto land</b>	
Reagents and processing cost	233	1.5 X Cost of reagents
Cost of whey disposal	2,784	3.5% reduction in whey volume
BOD reduction savings	-	6.3% BOD reduction, value not included
Sale of complex as fish feed	391	Fish feed \$560/ton, 12X protein content
Total cost	2,626	
<b>Net benefit</b>	<b>259</b>	<b>per 100,000 kg whey</b>

## Materials and Methods



## Benefits

- One step cost effective whey protein recovery for small to medium scale dairy manufacturers
- Recovery of 50% of whey proteins in native form
- Reduction in whey volume, BOD and turbidity
- Potential for feed and food grade applications
- Excellent source of stockfeed with amino acid profile and digestibility
- Selective removal of  $\beta$ -lactoglobulin

## Recommendations

- Trials with acid and salty whey
- Pilot scale trials and shelf life evaluation
- Development of small scale equipment
- Modification of cheese plant
- Fish feed trials
- New food products with high protein and fibre content

## Nutritional Value

Stockfeed	Crude Protein (%)	Methionine+ Cysteine Lysine (g/100g)
Maize	9	1.06
Sorghum	11	0.8
Soybean meal	48	4.86
Maize gluten	65	2.54
Wheat bran	18	2.31
Meat and bone meal	39	4.35
Fish meal	65	7.95
LV-CMC-WP	50	8.16
HV-CMC-WP	47	11.44

Better Amino Acid Profile than fish and meat meal

Increased profit for fish feed option, potential food applications with for better return.

Metabolisable Energy of the CMC-whey protein complexes were measured to be 15 MJ/kgDM higher than typical stockfeed 9-13 MJ/kgDM.

Better digestibility and metabolisable energy than any stockfeed

## Acknowledgements

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