FINAL REPORT

Sodium Reduction in Selected Food Products with Sodium Acid Sulfate and Potassium Acid Sulfate

Project # DEV 1675

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Sodium Reduction in Selected Food Products with Sodium Acid Sulfate and Potassium Acid Sulfate

Executive Summary

The results from the sodium reduction using pHase are very promising in several food products. The results from the sodium analysis of the carrots showed a 43% reduction in sodium, as compared to the control. The tomato and vegetable soups and the vegetable cocktail had similar reductions in sodium levels of 19%, 23% and 17% as compared to their respective controls. The cheddar cheese sauce had close to an 8% reduction and the alfredo sauce sowed the least amount of sodium reduction at less than 4%.

The use of potassium acid sulfate to reduce sodium also shows great potential in the carrots (46%), tomato soup (24%), vegetable cocktail (23%) and vegetable soup (21%) compared to the controls. The addition of potassium acid sulfate resulted in the same reduction in sodium in the cheese sauce as the pHase (~8%). The sodium reduction in the alfredo sauce was almost 10%.

The general sensory characteristics for the sodium reduced products were similar perceptions of saltiness when substituting pHase or potassium acid sulfate for a percentage of the salt. The flavours of the foods were enhanced in most cases, and there were few off-notes detected other than slight metallic or bitter notes, or a slight increased perception of sweetness in some of the products.

Background

Jones-Hamilton manufactures a unique ingredient called pHase, chemically known as sodium acid sulphate. In previous studies, Jones-Hamilton has shown that pHase is an excellent acidulant, can mask intense sweeteners, can reduce the amount of sweetener used, and can be used to reduce the pH in food products that typically require a high thermal process (i.e. retorting) such that a lower thermal process (i.e. hot-filling) may be applied. In previous studies conducted by the GFTC, there was some initial findings that pHase could reduce the sodium content in food products.

In this study, Jones-Hamilton would like to conduct lab scale trials to evaluate the sodium reduction potential of pHase (sodium acid sulfate) and a new product, potassium acid sulfate in several food products.

Project Objective

The objective of this project is to conduct preliminary investigative lab scale trials to determine the sodium reduction potential using pHase (sodium acid sulfate) or potassium acid sulfate in selected food products.

Materials and Methods

The required ingredients were sourced from either commercial suppliers or retail stores.

The following products were evaluated for sodium reduction potential with pHase and potassium acid sulfate:

- Condensed Tomato Soup
- Condensed Vegetable Soup
- Alfredo Sauce
- Cheese Sauce
- Canned Sliced Carrots
- Vegetable Juice Drink

An appropriate processing method was used for each product and will be detailed below with the formulation and results.

Each prototype was evaluated for general sensory attributes (flavour, appearance, texture) by three Product Developers. The pH was measured for each prototype and recorded.

Samples were sent to a laboratory for sodium analysis.

Preliminary Lab Scale Trials

A typical condensed tomato soup formulation was used and is shown below:

Control Formulation

Condensed Tomato Soup

Ingredient	%
Water	61.88
Tomato Paste	21.22
HFCS 55	10.61
Modified Starch[1]	3.45
Salt	1.95
Wheat Flour, All Purpose	0.88
Allspice	0.01
Total	100.00

[1]Modified Starch, Novation 3300, *Nacan*

pH = 4.46

Lab Scale Processing Method:

1. Slurry tomato paste with a portion of the water
2. Pre-slurry starch and wheat flour with a portion of the water
3. Combine all ingredients into pot and mix well
4. Heat to 185°F using a double boiler pot
5. Fill jars (leave approx. 1 inch headspace)
6. Process in a home canner (using 10lb pressure valve) for 30 minutes
7. Cool in warm water bath

Lab trials were conducted on the condensed tomato soup with reduced salt levels and various added levels of either pHase or potassium acid sulfate. The processing method remained the same.

The following trials were conducted:

Sodium reduction using pHase

Trial #	**1**	**2**
Approx. % sodium reduction	**50%**	**25%**
Ingredient	**%**	**%**
Water	62.78	62.31
Tomato Paste	21.22	21.22
HFCS 55	10.61	10.61
Modified Starch	3.45	3.45
Salt	**0.95**	**1.42**
Wheat Flour, All Purpose	0.88	0.88
Allspice	0.01	0.01
pHase	0.10	0.10
Total	100.00	100.00

pH = 4.26

Sensory Evaluation Results:

Trial #1 - Too sweet, not salty enough
Trial #2 – More cooked notes, slightly more acidic and more sweet, similar salty perception

Salt reduction using potassium acid sulfate

Trial #	**1**	**2**
Approx. % sodium reduction	**50%**	**25%**
Ingredient	**%**	**%**
Water	62.78	62.31
Tomato Paste	21.22	21.22
HFCS 55	10.61	10.61
Modified Starch	3.45	3.45
Salt	**0.95**	**1.42**
Wheat Flour, All Purpose	0.88	0.88
Allspice	0.01	0.01
Potassium acid sulfate	0.10	0.10
Total	100.00	100.00

pH = 4.30

Sensory Evaluation Results:

Trial #1 - Too sweet, not salty enough
Trial #2 – Slightly more sweet, similar salty perception

Condensed Vegetable Soup

A typical condensed vegetable soup formulation was used and is shown below:

Control Formulation

Ingredient	%
Water	53.32
Sliced Carrots	10.00
Cubed Potatoes	10.00
Tomato Paste	9.20
HFCS 55	4.50
Peas	4.30
Powdered Chicken Broth 3422[1]	2.33
Can-Fil, Modified Starch[2]	2.00
Pasta	1.40
Salt	1.08
Novation 3300, Modified Starch[3]	1.00
Yeast Extract, 0402/20-PO-L[4]	0.37
Garlic Powder	0.20
Onion Powder	0.20
Celery Concentrate, Blanched Note[5]	0.10
Total	100.00

[1]Chicken Broth, 3422 powdered, *IDF*
[2]Can-Fil Starch, *Nacan*
[3]Modified Starch, Novation 3300, *Nacan*
[4]Yeast Extract, 0402/20-PO-L, *Rene Rivet Inc*
[5]Celery Concentrate, *Diana Vegetal*

pH = 5.11

Lab Scale Processing Method:

1. Slurry tomato paste with a portion of the water
2. Pre-slurry starch and wheat flour with a portion of the water
3. Combine all ingredients into pot and mix well
4. Heat to 185°F using a double boiler pot
5. Fill jars (leave approx. 1 inch headspace)
6. Process in a home canner (using 10lb pressure valve) for 60 minutes
7. Cool in warm water bath

Lab trials were conducted on the condensed vegetable soup with reduced salt levels and various added levels of either pHase or potassium acid sulfate. The processing method remained the same.

The following trials were conducted:

Sodium reduction using pHase

Trial #	**1**	**2**	**3**	**4**
Approx. % sodium reduction	**50%**	**25%**	**50%**	**25%**
Ingredient	**%**	**%**	**%**	**%**
Water	54.12	53.58	53.76	53.49
Sliced Carrots	10.00	10.00	10.00	10.00
Cubed Potatoes	10.00	10.00	10.00	10.00
Tomato Paste	9.20	9.20	9.20	9.20
HFCS 55	4.50	4.50	4.50	4.50
Peas	4.30	4.30	4.30	4.30
Powdered Chicken Broth 3422	2.33	2.33	2.33	2.33
Starch, Can-Fil	2.00	2.00	2.00	2.00
Pasta	1.40	1.40	1.40	1.40
Salt	**0.54**	**0.81**	**0.54**	**0.81**
Starch, Novation 3300	0.54	0.54	0.54	0.54
Yeast Extract, 0402/20-PO-L	0.37	0.37	0.37	0.37
Garlic Powder	0.20	0.20	0.20	0.20
Onion Powder	0.20	0.20	0.20	0.20
Celery Concentrate, Blanched Note	0.10	0.10	0.10	0.10
pHase	0.20	0.20	0.10	0.10
Total	100.00	100.00	100.00	100.00

pH = 4.65

Sensory Evaluation Results:

Trial #1 – Sweeter, slight metallic off-flavour, less salty
Trial #2 – Slightly more sweet, less metallic, similar salty perception
Trial #3 – Sweet, less salty
Trial #4 – Slight metallic flavour, slightly more acidic, similar salty perception

Sodium reduction using potassium acid sulfate

Trial #	**1**	**2**	**3**	**4**
Approx. % sodium reduction	**50%**	**25%**	**50%**	**25%**
Ingredient	**%**	**%**	**%**	**%**
Water	54.12	53.58	53.76	53.49
Sliced Carrots	10.00	10.00	10.00	10.00
Cubed Potatoes	10.00	10.00	10.00	10.00
Tomato Paste	9.20	9.20	9.20	9.20
HFCS 55	4.50	4.50	4.50	4.50
Peas	4.30	4.30	4.30	4.30
Powdered Chicken Broth 3422	2.33	2.33	2.33	2.33
Starch, Can-Fil	2.00	2.00	2.00	2.00
Pasta	1.40	1.40	1.40	1.40
Salt	**0.54**	**0.81**	**0.54**	**0.81**
Starch, Novation 3300	0.54	0.54	0.54	0.54
Yeast Extract, 0402/20-PO-L	0.37	0.37	0.37	0.37
Garlic Powder	0.20	0.20	0.20	0.20
Onion Powder	0.20	0.20	0.20	0.20
Celery Concentrate, Blanched Note	0.10	0.10	0.10	0.10
Potassium acid sulfate	0.20	0.20	0.10	0.10
Total	100.00	100.00	100.00	100.00

pH = 4.87

Sensory Evaluation Results:

Trial #1 – Sweeter, slight bitter/metallic note, less salty
Trial #2 – Slightly more sweet, slight bitter/metallic note still evident
Trial #3 – Too sweet
Trial #4 – Good, less acidic

Alfredo Sauce

A formulation based on a previous study for Jones-Hamilton was used and is shown below:

Control Formulation

Ingredient	%
Water	47.01
Whipping Cream, 35%	46.00
Modified Starch[1]	2.15
Flavour[2], Butter Buds 32x	1.30
Sugar	1.15
Flavour[3], Parmesan Buds-Ex	1.07
Salt	0.90
Onion Powder	0.20
xanthan gum	0.10
Garlic Powder	0.10
White Pepper	0.02
Total	100.00

[1]Modified Starch, Frigex W, *Nacan*
[2]Butter Buds 32x, *Dealers Ingredients Inc.*
[3]Parmesan Buds Ex, Dealers Ingredients Inc.
pH = 6.10

Lab Scale Processing Method:

1. Pre-slurry starch with a portion of the water
2. Dry blend all dry ingredients together
3. Combine all ingredients into pot and mix well
4. When adding acidulent (pHase or potassium acid sulfate), add slowly after all other ingredients are mixed well
5. Heat to 185°F using a double boiler pot
6. Fill jars (leave approx. 1 inch headspace)
7. Process in a home canner (using 10lb pressure valve) for 30 minutes
8. Cool in warm water bath

Lab trials were conducted on the Alfredo sauce with reduced salt levels and various added levels of either pHase or potassium acid sulfate. The processing method remained the same.

The following trials were conducted:

Sodium reduction using pHase

Trial #	**1**	**2**
Approx. % sodium reduction	**50%**	**25%**
Ingredient	**%**	**%**
Water	47.21	47.01
Whipping Cream, 35%	46.00	46.00
Starch, Frigex W	2.15	2.15
Flavour, Butter Buds 32x	1.30	1.30
Sugar	1.15	1.15
Flavour, Parmesan Buds-Ex	1.07	1.07
Salt	**0.40**	**0.75**
Onion Powder	0.20	0.20
xanthan gum	0.10	0.10
Garlic Powder	0.10	0.10
White Pepper	0.02	0.02
pHase	0.30	0.15
Total	100.00	100.00

pH
Trial #1 = 4.19
Trial #2 = 5.15

Sensory Evaluation Results

Trial #1 – more acidic, more salty perception
Trial #2 – slightly acidic, slightly more bland, less garlic flavour, similar salty perception

Sodium reduction using potassium acid sulfate

Trial #	**1**	**2**
Approx. % sodium reduction	**50%**	**25%**
Ingredient	**%**	**%**
Water	47.21	47.01
Whipping Cream, 35%	46.00	46.00
Starch, Frigex W	2.15	2.15
Flavour, Butter Buds 32x	1.30	1.30
Sugar	1.15	1.15
Flavour, Parmesan Buds-Ex	1.07	1.07
Salt	**0.40**	**0.75**
Onion Powder	0.20	0.20
xanthan gum	0.10	0.10
Garlic Powder	0.10	0.10
White Pepper	0.02	0.02
Potassium acid sulfate	0.30	0.15
Total	100.00	100.00

pH
Trial #1 = 4.49
Trial #2 = 4.83

Sensory Evaluation Results

Trial #1 – more bitter, more sweet, less salty
Trial #2 – slightly more sweet, slight bitter note, less balanced flavour, similar salty perception

Cheese Sauce A typical cheese sauce formulation was used and is shown below:

Control Formulation

Ingredient	%	%
		50% Less Salt
Water	63.20	63.70
Cheddar Cheese	17.50	17.50
Butter Oil/Ghee	5.82	5.82
Whey Powder	4.45	4.45
Modified Starch[1]	4.20	4.20
Disodium phosphate	1.80	1.80
Flavour[2]-Cheddar Buds	1.30	1.30
Salt	1.00	0.50
Monosodium phosphate	0.40	0.40
Lactic acid 88%	0.30	0.30
Annatto	0.03	0.03
Total	100.00	100.00

[1]Modified Starch, Col-Flo, *Nacan*
[2]Cheddar Buds, *Dealers Ingredients Inc*.

pH = 6.13

Lab Scale Processing Method:

1. Dry blend all dry ingredients together
2. Combine all ingredients into pot, add water and mix well
3. Begin heating over medium heat until reaches 70°C
4. Add melted butter and annatto while stirring
5. Slowly add cheese and mix until smooth
6. Heat to 85°C
7. Fill jars
8. Cool in warm water bath

Lab trials were conducted on the cheese sauce with reduced salt levels and various added levels of either pHase or potassium acid sulfate. The processing method remained the same.

The following trials were conducted:

Sodium reduction using pHase

Trial #	**1**	**2** **Using Control 2 as reference**
Approx. % sodium reduction	**25%**	**13%**
Ingredient	**%**	**%**
Water	63.10	63.30
Cheddar Cheese	17.50	17.50
Butter Oil	5.82	5.82
Whey Powder	4.45	4.45
Starch	4.20	4.20
Disodium phosphate	1.80	1.80
Flavour – Cheddar Buds	1.30	1.30
Salt	**0.50**	**0.00**
Monosodium phosphate	0.40	0.40
Lactic acid 88%	0.30	0.30
Annatto	0.03	0.03
pHase	0.60	0.30
Total	100.00	100.00

pH = 5.77

Sensory Evaluation Result:

Trial #1 – sharper cheese flavour, slightly more acidic, similar salty perception
Trial #2 – more cheddar cheese flavour, preferred flavour over control, similar salty perception, very slight metallic note

Sodium reduction using potassium acid sulfate

Trial #	1	2 Using Control 2 as reference
Approx. % sodium reduction	**25%**	**19%**
Ingredient	**%**	**%**
Water	63.10	63.30
Cheddar Cheese	17.50	17.50
Butter Oil	5.82	5.82
Whey Powder	4.45	4.45
Starch	4.20	4.20
Disodium phosphate	1.80	1.80
Flavour – Cheddar Buds	1.30	1.30
Salt	**0.50**	**0.00**
Monosodium phosphate	0.40	0.40
Lactic acid 88%	0.30	0.30
Annatto	0.03	0.03
Potassium acid sulfate	0.60	0.30
Total	100.00	100.00

pH = 5.77

Sensory Evaluation Results:

Trial #1 – slightly more salty perception, more bitter
Trial #2 – more cheese flavour but different cheese flavour profile (more similar to parmesan cheese flavour), similar salty perception

Canned Sliced Carrots

A typical canned sliced carrot formulation was used and is shown below:

Brine Solution

Ingredient	%
Water	98.50
Salt	1.50
Total	100.00

Target Fill Wts

Ingredient	%
Brine	40.00
Carrots	60.00
Total	100.00

pH = 5.19

Lab Scale Processing Method:

1. Wash and peel carrots
2. Slice into ¼" slices
3. Blanch carrots for 4 minutes at 190°F, rinse with cold water
4. Heat brine to 180°F
5. Fill jars with carrots and top with brine
6. Process in home canner (using 10lb pressure valve) for 25 minutes
7. Cool in warm water bath

Lab trials were conducted on the cheese sauce with reduced salt levels and various added levels of either pHase or potassium acid sulfate. The processing method remained the same.

The following trials were conducted:

Sodium reduction using pHase

Brine Solution

Trial #	1	2
Approx. % sodium reduction	50%	50%
Ingredient	%	%
Water	99.15	99.15
Salt	0.75	0.75
pHase	0.10	0.05
Total	100.00	100.00

Target Fill Wts

Ingredient	%
Brine	40.00
Carrots	60.00
Total	100.00

pH

Trial #1 = 4.36
Trial #2 = 4.74

Sensory Evaluation Results

Trial #1 – slightly sweeter, more fresh carrot flavour, metallic note
Trial #2 – more fresh carrot flavour, slight metallic note, similar salty perception

Sodium reduction using potassium acid sulfate

Brine Solution

Trial #	**1**	**2**
Approx. % sodium reduction	**50%**	**50%**
Ingredient	**%**	**%**
Water	99.15	99.15
Salt	**0.75**	**0.75**
Potassium acid sulfate	0.10	0.05
Total	100.00	100.00

Target Fill Wts

Ingredient	**%**
Brine	40.00
Carrots	60.00
Total	100.00

pH

Trial #1 = 4.42
Trial #2 = 4.79

Sensory Evaluation Results:

Trial #1 – similar salty perception, metallic note
Trial #2 – similar salty perception, very slight metallic note

V8 Type Juice A typical Vegetable juice formulation was used and is shown below:

Control Formulation

Ingredient	%
Water	86.70
Tomato Paste	10.11
HFCS 55	1.95
Salt	0.715
Vegetable Blend Concentrate[1] CLWCCS0001	0.25
Citric Acid	0.15
Vegetable Flavour[2]	0.07
Green Pepper Flavour[3] WONF 112.3258	0.03
Parsley Extract[4] 132.C552	0.025
Total	100.00

[1]Vegetable Blend Concentrate CLWCCS0001, *Diana Vegetal*
[2]Vegetable Mixed Type Flavour, Natural 132.11053, *Bell Flavors*
[3]Green Pepper Flavour, WONF 112.3258, *Bell Flavors*
[4]Parsley Extract 132.C552, *Bell Flavors*

pH = 3.80

Lab Scale Processing Method:

1. Combine all ingredients in kettle
2. Pasteurize at 195°F for 1 minute
3. Hot fill into bottles
4. Cool in a cool water bath

Lab trials were conducted on the Vegetable juice with reduced salt levels and various added levels of either pHase or potassium acid sulfate. The processing method remained the same.

The following trials were conducted:

Sodium reduction using pHase

Approx. % sodium reduction	**25%**
Ingredient	**%**
Water	86.78
Tomato Paste	10.11
HFCS 55	1.95
Salt	**0.536**
Vegetable Blend Concentrate CLWCCS0001	0.25
Citric Acid	0.15
Vegetable mixed type flavour nat 132.11053	0.07
Green Pepper WONF 112.3258	0.03
Parsley Extract 132.C552	0.025
pHase	0.10
Total	100.00

pH = 3.5

Sensory Evaluation Results – stronger flavour, especially tomato and celery, fresher tomato flavour, similar salty perception

Sodium reduction using potassium acid sulfate

Approx. % sodium reduction	**25%**
Ingredient	**%**
Water	86.78
Tomato Paste	10.11
HFCS 55	1.95
Salt	**0.536**
Vegetable Blend Concentrate CLWCCS0001	0.25
Citric Acid	0.15
Vegetable mixed type flavour nat 132.11053	0.07
Green Pepper WONF 112.3258	0.03
Parsley Extract 132.C552	0.025
Potassium Acid Sulfate	0.10
Total	100.00

pH = 3.5

Sensory Evaluation Results – stronger vegetable flavour, less celery flavour, fresher tomato flavour, similar salty perception

Results and Discussion

Lab samples of the acceptable preliminary trials were re-made and sent to a laboratory for sodium analysis. Below is a summary chart of these samples and sodium content results.

Table 1: Summary Chart of Selected Products and the Resulting Sodium Content

	Sample	pH	% sodium	Typical serving size	mg sodium / serving
Condensed Vegetable Soup	Control	5.03	100	125 mL	662.5
	pHase	4.87	77.4		512.5
	KAS	4.75	79.2		525
Condensed Tomato Soup	Control	4.22	100	125 mL	987.5
	pHase	4.11	81.0		800
	KAS	4.03	75.9		750
Alfredo Sauce	Control	6.03	100	¼ cup (60 mL)	312
	pHase	5.23	96.15		300
	KAS	5.03	90.4		282
Cheese Sauce	Control	6.07	100	¼ cup (60 mL)	780
	pHase	5.73	92.3		720
	KAS	5.68	92.3		720
Sliced Carrots	Control	5.18	100	130 g	364
	pHase	5.13	57.14		208
	KAS	5.19	53.57		195
Vegetable Juice	Control	3.80	100	8 oz (243 g)	729
	pHase	3.50	83.3		607.5
	KAS	3.50	76.7		558.9

* based on theoretical calculations
KAS = potassium acid sulfate
Density of Tomato Soup = 1.12
Density of Vegetable Soup = 1.06
Density of Alfredo Sauce = 1.00
Density of Cheese Sauce = 1.05

A cross-section of food products was selected that typically contain high sodium levels. The goal of this study was to evaluate the potential of two ingredients, pHase (sodium acid sulfate) and potassium acid sulfate to effectively reduce the sodium content of these foods and determine the impact on product quality.

Previous studies conducted at the GFTC using pHase in retorted products, indicated that the addition of pHase resulted in the addition of less salt.

Based on lab scale trials, relatively low levels of pHase and potassium acid sulfate were required to reduce the sodium content of the selected foods. A range of 0.05% to 0.6% was required in this study, depending on the food application. A summary of the usage levels and corresponding sodium reductions is shown below:

Table 2: Usage Levels of pHase and Potassium Acid Sulfate (KAS) Required to Reduce the Sodium Content of Selected Food Products

Product	Usage Level pHase	Usage Level KAS	% Sodium Reduction With pHase	% Sodium Reduction With KAS
Condensed Tomato Soup	0.1%	0.1%	19.0	24.1
Condensed Vegetable Soup	0.1%	0.1%	22.6	20.8
Alfredo Sauce	0.15%	0.15%	3.9	9.6
Cheese Sauce	0.3-0.6%	0.3-0.6%	7.7	7.7
Sliced Carrots	0.05-0.1%	0.05-0.1%	42.9	46.4
Vegetable Juice	0.1%	0.1%	16.7	23.3

From tables 1 and 2, it was found that the sodium content of the selected foods was reduced between 3.9 and 46.4%. The sensory evaluations of the sodium reduced products showed that a similar salty perception could be achieved at the reduced levels with minimal effect on the flavour profile.

The sweetness of several samples containing pHase or potassium acid sulfate was more evident. It is hypothesized that pHase and potassium acid sulfate may also enhance the sweetener in the products. Formulation modifications to reduce the sweetener can be done to decrease the sweetness if desired.

It was also noted that several other flavour components were enhanced by

the addition of pHase or potassium acid sulfate. For example, the garlic flavour in the Alfredo sauce sample with added pHase seemed accentuated. The cheese flavour in the cheese sauce with added pHase or potassium acid sulfate seemed stronger in flavour. However, the sample with pHase had more of a tangy cheddar flavour whereas the sample with potassium acid sulfate had more of a parmesan or old cheddar cheese flavour.

The vegetable flavors accentuated in the Vegetable juice also differed depending on whether pHase or potassium acid sulfate was added. Generally, it was found that pHase attributed a slight acidic or tanginess and a "fresh, zesty" flavour to the products. The potassium acid sulfate seemed to be more neutral in flavour enhancement with some bitterness.

In some cases, a metallic or bitter flavour was detected in the samples containing pHase or potassium acid sulfate. Generally this off-note was subtle and may be improved if other formulation modifications are made (such as increasing desirable flavours and spices and/or adding masking flavours).

The cream based products (Alfredo sauce and cheddar cheese sauce) had the least amount of sodium reduction. This was due to the difficulty in reducing the sodium content with addition of pHase or potassium acid sulfate without changing the flavour profile significantly. These products have a high pH and the addition of pHase and potassium acid sulfate causes the pH to decrease. The acidic flavour that results changes the flavour profile. However, it was shown in a previous study with the Alfredo sauce that further formulation modifications can be made to make the product acceptable. Further sodium reduction may also be possible with the cheddar cheese sauce. In the formulation used in this study, all of the salt was removed with the added pHase or potassium acid sulfate. Both the control and sodium reduced samples were still very salty. Sodium can be further reduced with the reduction of salt in the cheese and/or the emulsifiers used (disodium and monosodium phosphates)

Summary and Recommendations

The results from the sodium reduction using pHase are very promising in several cases. The results from the sodium analysis of the carrots showed reductions in sodium of greater than 42%. The vegetable cocktail had almost 17% less sodium than the control, while the cheddar cheese sauce had close to an 8% reduction. The tomato soup and vegetable soup had reductions of almost 19% and 23%, respectively. The alfredo sauce resulted in the lowest sodium reduction at less than 4%.

The use of potassium acid sulfate to reduce sodium also shows great potential in the carrots (46%), tomato soup (24%) and vegetable cocktail (23%). The potassium acid sulfate had the same reduction in sodium in the cheese sauce as the pHase (~8%), and showed a 21% decrease in sodium in the vegetable soup. The sodium reduction in the alfredo sauce was nearly 10%.

It is recommended that sodium reduction using pHase and potassium acid sulfate in other vegetables and soups be evaluated. Further research into sodium reduction with these products may be done for sauces. Evaluation of the effect of pHase and potassium acid sulfate on sweetness may be considered.