1990

1989-1990 Annual Report

Various Authors

Western Dairy Foods Research Center

Researching the Western
U.S. Dairy Industry's Future

Annual Report
1989-1990

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WESTERN DAIRY FOODS RESEARCH CENTER
OPERATIONAL ADVISORY COMMITTEE

Pursuant to the WDFRC proposal and contract with the National Dairy Promotion and Research Board, the voting members of the Operational Advisory Committee are:

Janet C. Williams
Director of Research
National Dairy Promotion and
Research Board
95 King Street
Elk Grove Village, IL 60007
(708) 228-7742

Doyle J. Matthews, Dean
College of Agriculture
Utah State University
Logan, UT 84322-4800
(801) 750-2215

Daniel F. Farkas, Head
Department of Food Science
and Technology
Wiegand Hall 240
Oregon State University
Corvallis, OR 97331
(503) 737-3131

Rodney J. Brown, Head
Department of Nutrition and
Food Sciences
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Logan, UT 84322-8700
(801) 750-2102

W. Lee Reese
Utah Dairy Commission
4443 North 2400 West
Benson, UT 84335
(801) 752-3572

Gale Moser
United Dairymen of Idaho
1864 South Hulls Crossing
Preston, ID 83263
(208) 852-0560

Tom Holzinger
Borden, Inc.
960 Kingsmill Parkway
Columbus, OH 43229
(614) 431-6623

Sheldon Pratt
Oregon Dairy Products Commission
10505 S.W. Barbur Blvd.
Portland, OR 97219
(503) 229-5033

Ray Focht
Western Dairy Farmers Prom. Assoc.
335 Focht Road
Lander, WY 82520
(307) 332-3123

Dave Mehnert
Kraft, Inc.
Research and Development Div.
801 Waukegan Road
Glenview, IL 60025
(312) 998-3717

Jeff Strandholm
Kraft, Inc.
Research and Development Div.
801 Waukegan Road
Glenview, IL 60025
(312) 998-3717

Raj G. Narasimmon
Schreiber Foods, Inc.
P.O. Box 19010
Green Bay, WI 54305
(414) 437-7601

Douglas Willrett
Marschall Products
P.O. Box 592
Madison, WI 53701
(608) 276-3600

WESTERN DAIRY FOODS RESEARCH CENTER

PRINCIPAL INVESTIGATORS

Floyd W. Bodyfelt
Dept. of Food Science & Technology
Oregon State University
Corvallis, OR 97331

Rodney J. Brown
Dept. of Nutrition & Food Sciences
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Logan, UT 84322-8700

Daren P. Cornforth
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Mark A. Daeschel
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Bruce L. Geller
Dept. of Microbiology
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Conly L. Hansen
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Jeffery K. Kondo
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WESTERN DAIRY FOODS RESEARCH CENTER

BUDGET ACTIVITY
(1989-1990 Fiscal Year)

1.	National Dairy Promotion and Research Board		**$400,000.00**
2.	Regional/IndustryUSDA Support		
	a. Regional Support:		
	Utah Dairy Commission	$49,999.92	
	Oregon Dairy Products Commission	$40,000.00	
	United Dairymen of Idaho	$50,000.00	
	Western Dairy Farmers Promotion Assoc.	$10,000.00	
	Regional Subtotal	$149,999.92	
	b. Industry Support:		
	Kraft	$5,000.00	
	Miles	$10,000.00	
	Schreiber Foods, Inc.	$5,000.00	
	Western Dairymen Cooperative Inc.	$2,500.00	
	Industry Subtotal	$22,500.00	
	c. USDA Agricultural Research Service (ARS)	$180,000.00	
	Total Regional and Industry Support		**$352,499.92**
3.	Institutional Support (Utah State University, Oregon State University, Brigham Young University)		**$775,837.00**
TOTAL BUDGET			**$1,528,336.92**
RESEARCH BUDGET			**$752,499.92**
AVAILABLE FUNDS FOR ALLOCATION (minus USDA-ARS funds)			**$572,499.92**

SUMMARY OF TOTAL BUDGET FOR ALL YEARS
(AVAILABLE FUNDS FOR ALLOCATION AND COMMITMENTS)

FUNDS	FY88	FY89	FY90	FY91	FY92
COMMITTED	$394,264	$743,187	$517,886	$545,740	$265,370
[Allocation Pending				22,000	23,100]
CONTRIBUTIONS	555,000	570,000	572,499.92	570,000*	570,000*
BALANCE (deficit)	160,736	(173,187)	54,613.92	2,260	281,530
TOTAL AVAILABLE: --		($12,451)	$42,162.92	$44,422.92	$325,952.92

* Projected funds from WDFRC contributors

Western Dairy Center Listing of Funded Projects By Account Number

Account Number	Proj Numb	Principal Investigator	Research Area	Research Title	Project Start Date	Project Ending Date	Project Funding Allocated Thru FY 1992								
							FY 88			FY 89					
							Non-Dairy Board	Dairy Board	Total	Non-Dairy Board	Dairy Board	Total	FY 90	FY 91	FY 92
547877	212	Torres, J. Antonio	Product Quality	Acid Whey Utilization: Functional Properties of a Food Grade Stabilizer Produced by Lactobacillus Plantarum from Acid Whey	07/01/89	06/30/91	0	0	0	0	0	0	20580	22797	0
547766	189	Hansen, Conly L.	Ultrafiltration and Reverse Osmosis	Cogeneration of Biogas and Single Cell protein From Ultrafiltration Permeate and Whey	07/01/87	06/30/89	9863	19726	29589	29589	0	29589	0	0	0
547767	188	Kondo, Jeffery K.	Microbiology of Starter Cultures	Cloning the Nisin and Other Genes of Lactic Streptococci into Leuconostoc Species and Amplification of Nisin Production	07/01/87	06/30/92	13893	27787	41680	11479	22961	34440	32105	33711	35396
547768	182	Mahoney, Arthur W.	Product Quality	Iron fortification of cheese curd	08/01/87	06/30/90	6981	13963	20944	7251	14502	21753	0	0	0
547769	190	Richardson, Gary H.	Product Quality	Acquisiton of Zymark II Robot for Laboratory Automation Studies	07/01/87	06/30/90	1667	3333	5000	0	0	0	0	0	0
547780	181	Richardson, Gary H.	Curd Formation/ Cheese Tech.	Improving Yield and Physical Properties of Mozzarella Cheese	07/01/87	06/30/91	7540	15080	22620	7553	15067	22620	22620	0	0
547781	183	Ernstrom, C. Anthon	Ultrafiltration and Reverse Osmosis	Continuous Production of Cottage Cheese From Ultra-filtrated skim milk Retenate	09/01/87	08/31/89	0	8700	8700	0	0	0	0	0	0

							Project Funding Allocated Thru FY 1992								
							FY 88			FY 89					
Account Number	Proj Numb	Principal Investigator	Research Area	Research Title	Project Start Date	Project Ending Date	Non-Dairy Board	Dairy Board	Total	Non-Dairy Board	Dairy Board	Total	FY 90	FY 91	FY 92
547782	184	Cornforth, Daren P.	Product Quality	Evaluation of Milk Proteins as Whitening Agents in Processed Meats and Poultry Products	07/01/87	6/30/90	5109	10218	15327	5504	11008	16512	0	0	0
547783	186	Olsen, Robert L.	Curd Formation/ Cheese Tech.	Interaction of Protein and Polysaccharides in Chymosin and Acid Coagulation of Milk	07/01/87	06/30/89	7250	14500	21750	7136	14274	21410	0	0	0
547784	187	Richardson, Gary H.	Curd Formation/ Cheese Tech.	Improved Control of Cheese Manufacture Through Vat Monitoring	07/01/87	06/30/91	11767	23533	35300	4675	9325	14000	14000	0	0
547785	191	Kondo, Jeffery K.	Administrative Expenses	Western Dairy Foods Research Center Administrative Account	07/01/87	06/30/92	6667	13333	20000	6667	23333	30000	30000	50000	50000
547802	192	Ernstrom, C. Anthon	Curd Formation/ Cheese Tech.	Effect of Milk Clotting Enzymes on the Curing and Quality of Cheddar Cheese	07/01/87	06/30/88	12575	25085	37660	0	0	0	0	0	0
547804	188	Sandine, W.E.	Microbiology of Starter Cultures	Cloning the Nisin and Other Genes of Lactic Streptococci into Leuconostoc Species and Amplification of Nisin Production	07/01/87	06/30/92	14855	29710	44565	14345	28689	43033	45274	47537	49914
547810	194	Sandine, W.E.	Microbiology of Starter Cultures	Characterization of Bacteriophage Receptor Sites of Lactic Streptococci	07/01/87	06/30/90	6037	12073	18110	6191	12382	18573	18573	0	0
547811	195	Bodyfelt, Floyd W.	Product Quality	Rapid Assay for Heat Resistant Microbial Proteases in Raw Milk by a Simple Casein Denaturation Method	08/01/87	12/31/90	6094	12191	18285	1012	2023	3035	15260	0	0

Account Number	Proj Numb	Principal Investigator	Research Area	Research Title	Project Start Date	Project Ending Date	Project Funding Allocated Thru FY 1992								
							FY 88			FY 89					
							Non-Dairy Board	Dairy Board	Total	Non-Dairy Board	Dairy Board	Total	FY 90	FY 91	FY 92
547812	196	Bodyfelt, Floyd W.	Microbiology of Starter Cultures	Production of Omega-3 Fatty Acids by Genetically Altered Fungi and Lactic Acid Bacteria	09/01/87	12/31/90	8117	16233	24350	1805	3610	5415	24890	0*	0
547813	197	McGuire, Joseph	Product Quality	Characterization of the Post-Absorbtive Behavior of B-Lactoglobulin For Control of Spore and Microbial Adhesion	01/01/88	12/31/90	6970	13940	20910	10347	20695	31043	24643	0	0
547814	198	Sandine, W.E.	Microbiology of Starter Cultures	Studies on the Growth and Survival of Bifidobacterium Species in Milk	07/01/87	06/30/89	6037	12073	18110	6191	12382	18573	0	0	0
547822	183	Ogden, Lynn, V.	Ultrafiltration and Reverse Osmosis	Continuous Production of Cottage Cheese From Ultrafiltrated Skim Milk Retenate	09/01/87	08/31/89	0	0	0	2733	5467	8200	0	0	0
547823	199	Ogden, Lynn V.	Product Quality	Method for Identifying Batch of Origin of Semi-continuous Cheese Processes	07/01/88	06/30/90	0	0	0	6100	0	6100	6100	0	0
547825	201	Brown, Rodney J.	Product Quality	Application of Fourier Transform Infrared Technology to Milk and Dairy Products	07/01/88	04/30/91	0	0	0	50250	23100	73350	25205	26366	0
547827	267	Brown, Rodney J.	Product Quality	Estimation of Individual Milk Proteins and Genetic Variants by Multicomponent Analysis of Amino Acid Profiles	07/01/88	06/30/91	0	0	0	16125	129300	145425	50594	51874	0

Account Number	Proj Numb	Principal Investigator	Research Area	Research Title	Project Start Date	Project Ending Date	Project Funding Allocated Thru FY 1992								
							FY 88			FY 89					
							Non-Dairy Board	Dairy Board	Total	Non-Dairy Board	Dairy Board	Total	FY 90	FY 91	FY 92
547828	204	Savello, Paul A.	Ultrafiltration and Reverse Osmosis	Use of Ultrafiltration and Different Heat Treatments on Yogurt Flavor and Physical Properties	08/01/88	06/30/91	0	0	0	9500	19000	28500	29700	0	0
547833	203	Daeschel, Mark A.	Microbiology of Starter Cultures	Purification of a Bacteriocin From Pediococcus Pentosaceus and Genetic Transfer of the Plasmid Borne Determinant	07/01/88	06/30/91	0	0	0	5354	10708	16062	18100	20300	0
547834	202	Torres, J. Antonio	Curd Formation/ Cheese Tech.	Cheddar Cheese Blocks: Effect of Cheese Composition and Cooling Method	07/01/88	12/31/90	0	0	0	15176	11354	26530	16212	0	0
547838	206	Hansen, Conly L.	Curd Formation/ Cheese Tech.	Comparison Between 40 and 640 lb Blocks of Uniform Cooling of 640 lb Blocks	11/01/88	12/31/91	0	0	0	0	2300	2300	11000	4600	0
547839	200	McMahon, Donald J.	Ultrafiltration and Reverse Osmosis	Variations in Casein Composition of Milk High Yield, Low Moisture Cheese From Homogenized Milk	09/01/88	08/31/91	0	0	0	0	24936	24936	26543	27877	0
547841	208	Mahoney, Arthur W.	Product Quality	Evaluation of Iron-Protein Complexes in Iron-Fortified Dairy Products	10/04/88	6/30/91	0	0	0	0	35505	35505	8090	38442	0
547848	210	Hansen, Conly L.	Curd Formation/ Cheese Tech.	A New Method for Measuring Syneresis of Renneted Gels Applied to Development of Cheese	03/01/89	03/01/91	0	0	0	7971	15941	23912	0	0	0
547862	206	Torres, J. Antonio	Curd Formation/ Cheese Tech.	Cooling Rate of Cheddar Cheese: Comparison Between 40 and 640 lb Blocks of Uniform Cooling of 640 lb Blocks	11/01/88	12/31/91	0	0	0	3850	7699	11549	18320	2475	0

Account Number	Proj Numb	Principal Investigator	Research Area	Research Title	Project Start Date	Project Ending Date	Project Funding Allocated Thru FY 1992								
							FY 88			FY 89					
							Non-Dairy Board	Dairy Board	Total	Non-Dairy Board	Dairy Board	Total	FY 90	FY 91	FY 92
547863	209	McDaniel, Mina R.	Product Quality	Optimization of the Sensory Qualities of Flavored Yogurt	07/01/88	06/30/90	0	0	0	10763	21364	32127	0	0	0
547864	207	Daeschel, Mark A.	Microbiology of Starter Cultures	Prediction and Determination of the Efficacy of Nisin in Dairy Foods	07/01/88	03/31/91	0	0	0	6076	12154	18230	21177	0	0
547867	211	McMahon, Donald J.	UHT Processing	Function of Whey Proteins and Lactose in Age Gelation of Ultra-High Temperature Sterilized Milk Concentrate	07/01/89	06/30/91	0	0	0	0	0	0	25000	25000	0
547899	210	Hansen, Conly L.	UF/RO	Development of a process for production of UF milk retentate powder	07/01/90	06/30/92	0	0	0	0	0	0	0	61405	64415
547902	198	Sandine, William E.	Microbiology of Starter Cultures	Growth ofbifidobacteria in milk: Association with Streptococcus thermophilus and Lactobacillus species as measured by genetic and enzymatic probes	07/01/90	06/30/92	0	0	0	0	0	0	0	25453	26315
547898	204	Savello, Paul A.	UF/RO	Membrane fractionation of immunoglobulins from milk and whey	07/01/90	06/30/91	0	0	0	0	0	0	0	33,500	0
		Brown, Rodney J. Kondo, Jeffery K.	Microbiology of Starter Cultures	Characterization of milk proteolysis by lactococcal starter culture strains using amino acid analysis	07/01/90	06/30/92	0	0	0	0	0	0	0	22000	23100
547903	212	Penner, Michael	Product Quality	Utilization of acid whey as a substrate for the production of food grade cellulases	07/01/90	06/30/91	0	0	0	0	0	0	0	20583	0

Account Number	Proj Numb	Principal Investigator	Research Area	Research Title	Project Start Date	Project Ending Date	Project Funding Allocated Thru FY 1992								
							FY 88			FY 89					
							Non-Dairy Board	Dairy Board	Total	Non-Dairy Board	Dairy Board	Total	FY 90	FY 91	FY 92
547900	211	McMahon, Donald J.	UHT Processing	Controlling age gelation of UHT sterilized milk concentrates	07/01/90	06/30/92	0	0	0	0	0	0	0	34440	38740
547901	181	Richardson, Gary H.	Product Quality	Causes and prevention of sticky texture in Mozzarella cheese	07/01/90	06/30/91	0	0	0	0	0	0	0	19380	0
TOTAL							131422	271478	402900	253643	509079	762722	492722	567740	287880

LEGEND:

[ ] - Increase in project funding approved for FYs

* - Decrease in project funding approved for FYs

(___) - Extension (no cost) approved

(.....) - Project revision approved

WDFRC Project List by Research Area
(Projects Active or Terminated During FY90)

Curd Formation/Cheese Technology

- Improvement of Mozzarella Cheese Yield and Physical Properties through Proteinase Modification of Starter Cultures
  Dr. Gary H. Richardson
  Utah State University

- Improved Control of Cheese Manufacture Through Vat Monitoring
  Dr. Gary H. Richardson
  Utah State University

- Cheddar Cheese Blocks: Effect of Cheese Composition and Cooling Method
  Dr. J. Antonio Torres
  Oregon State University

- Comparison Between 40 and 640 lb Blocks of Uniform Cooling of 640 lb Blocks
  Dr. Conly L. Hansen
  Utah State University
  and
  Dr. J. Antonio Torres
  Oregon State University

Product Quality

- Acid Whey Utilization: Functional Properties of a Food Grade Stabilizer Produced by *Lactobacillus plantarum* from Acid Whey
  Dr. J. Antonio Torres
  Oregon State University

- Iron Fortification of Cheese Curd
  Dr. Arthur W. Mahoney
  Utah State University

- Evaluation of Milk Proteins as Whitening Agents in Processed Meats and Poultry Products
  Dr. Daren P. Cornforth
  Utah State University

- Rapid Assay for Heat Resistant Microbial Proteases in Raw Milk by a Simple Casein Denaturation Method
  Professor Floyd W. Bodyfelt
  Oregon State University

- Characterization of the Post-Absorptive Behavior of β-Lactoglobulin for Control of Spore and Microbial Adhesion to Dairy Product Processing and Packaging Surfaces
  Dr. Joseph McGuire
  Oregon State University

- Method of Identifying Batch of Origin in Semi-Continuous Cheese Processes
  Dr. Lynn V. Ogden
  Brigham Young University

- Application of Fourier Transform Infrared Technology to Milk and Dairy Products
  Dr. Rodney J. Brown
  Utah State University

- Estimation of Individual Milk Proteins and Genetic Variants by Multicomponent Analysis of Amino Acid Profiles
  Dr. Rodney J. Brown
  Utah State University

- Evaluation of Iron-Protein Complexes in Iron-Fortified Dairy Products
  Dr. Arthur W. Mahoney
  Utah State University

- Optimization of the Sensory Qualities of Flavored Yogurt
  Dr. Mina R. McDaniel
  Oregon State University

Ultrafiltration/Reverse Osmosis

- Properties of Low-Fat Yogurt Manufactured from Ultrafiltered and Ultra-High Temperature Treated Milk
  Dr. Paul A. Savello
  Utah State University

- High Yield, Low Moisture Cheese from Homogenized Ultrafiltered Milk
  Dr. Donald J. McMahon
  Utah State University

- Continuous Production of Cottage Cheese from Ultrafiltered Skim Milk Retentate
  Dr. Lynn V. Ogden
  Brigham Young University

Microbiology of Starter Cultures

- Cloning the Nisin and Other Genes from *Lactococcus* into *Leuconostoc* Species and Amplification of Nisin Production
  Dr. Jeffery K. Kondo
  Utah State University
  and
  Dr. William E. Sandine
  Oregon State University

- Characterization of Bacteriophage Receptor Sites of *Lactococcus* Bacteria
  Dr. William E. Sandine
  Oregon State University

- Production of Omega-3 Fatty Acids by Genetically Altered Fungi and Lactic Acid Bacteria
  Professor Floyd W. Bodyfelt
  Oregon State University

- Purification of a Bacteriocin From *Pediococcus pentosaceus* and Genetic Transfer of the Plasmid Borne Determinants
  Dr. Mark A. Daeschel
  Oregon State University

- Prediction and Determination of the Efficacy of Nisin in Dairy Foods
  Dr. Mark A. Daeschel
  Oregon State University

Ultra-High Temperature (UHT) Processing

- Function of Whey Proteins and Lactose in Age Gelation of Ultra-High Temperature Sterilized Milk Concentrate
  Dr. Donald J. McMahon
  Utah State University

ANNUAL REPORT

Annual Report Date (include year): September 30, 1990 (FY90)

Dairy Food Research Center (identify site): Western Dairy Foods Research Center

Dairy Center Director: Jeffery K. Kondo

Committee Approval (identify Committee and Committee members):

Center Activities (Center funded):

1. Seminars (list titles and presenters):

"Casein Micelle Structure"
Dr. Lawrie Creamer
Protein Chemistry Section Head
New Zealand Dairy Research Institute
December 6, 1989

"Opportunities in Biotechnology for the Dairy Industry"
Dr. Martin L. Playne
President, Australian Biotechnology Association
Principal Research Scientist, CSIRO
June 11, 1990

2. Symposia (list program titles, dates and include a printed program from the meeting):

None held during Fiscal Year 1990

3. Presentations given by Center personnel (list title, speaker, and audience; include abstracts submitted for professional meetings):

Mina R. McDaniel, P.I.

Barnes, D.L., Harper, S.J., and McDaniel, M.R. Correlation of descriptive and consumer panel flavor ratings for commercial pre-stirred strawberry yogurts. Paper no. 471. Institute of Food Technologists Annual Meeting. Anaheim, CA. June 1990.

Harper, S.J., Barnes, D.L., Bodyfelt, F.W., and McDaniel, M.R. Correlation of descriptive and consumer panel flavor ratings for commerical pre-stirred lemon yogurts. J. Dairy Sci. 73(Suppl. 1):93.

Harper, S.J., Barnes, D.L., Bodyfelt, F.W., and McDaniel, M.R. Sensory ratings of commercial plain yogurts by consumer and descriptive panels. J. Dairy Sci. 73(Suppl. 1):93.

Barnes, D.L., Harper S.J., Bodyfelt, F.W., and McDaniel, M.R. The effect of commercial yogurt sweetness-sourness ratios on consumer acceptance. J. Dairy Sci. 73(Suppl. 1):93.

Joseph McGuire

Krisdhasima, V., P. Suttiprasit, K. Al-malah, J. McGuire and R.D. Sproull. Post-adsorptive behavior of β-lactoglobulin. 78th Annual Oregon Dairy Industries Conference. Eugene, OR. 1989.

McGuire, J. Temperature influences on food contact surface energetics. Paper no. 22.20, 5th International Congress on Engineering and Food. Cologne, Federal Republic of Germany. 1989.

Kirtley, S.A. and J. McGuire. Exploitation of differences in surface constitution of food contact materials. Paper no. 217. Institute of Food Technologists Annual Meeting. Chicago, IL. 1989.

Krisdhasima, V., E. Lee, R.D. Sproull and J. McGuire. Temperature influences on food contact surface properties. Paper no. 218. Institute of Food Technologists Annual Meeting. Chicago, IL. 1989.

Krisdhasima, V., R.D. Sproull and J. McGuire. Application of ellipsometry to the study of food protein behavior at interfaces. Paper no. 702, Institute of Food Technologists Annual Meeting. Chicago, IL. 1989.

Krisdhasima, V., P. Suttiprasit, J. McGuire and R.D. Sproull. Post-adsorptive behavior of β-lactoglobulin. 79th Annual Oregon Dairy Industries Conference. Eugene, OR. 1990.

Suttiprasit, P. and J. McGuire. Relative interfacial behavior of milk proteins at hydrophobic and hydrophilic surfaces. Paper no. 37. Institute of Food Technologists Annual Meeting. Anaheim, CA. 1990.

Joseph McGuire (continued)

Al-malah, K. and J. McGuire. Application of ellipsometry to the characterization of milk soils on fouled and cleaned surfaces. Paper no. 39. Institute of Food Technologists Annual Meeting. Anaheim, CA. 1990.

Yang, J., J. McGuire and E.R. Kolbe. Use of the equilibrium contact angle as an index of contact surface cleanliness. Paper no. 154. Institute of Food Technologists Annual Meeting. Anaheim, CA. 1990.

Al-malah, K., J. Luey, J. McGuire and R.D. Sproull. β-lactoglobulin adsorption equilibrium at solid surfaces. To be presented at the AIChE Summer National Meeting, San Diego, CA. 1990.

Krisdhasima, V., J. McGuire, and R.D. Sproull. Surface-induced conformational changes experienced by β-lactoglobulin at hydrophilic and hydrophobic surfaces. To be presented at the AIChE Summer National Meeting, San Diego, CA. 1990.

Mark Daeschel

Daeschel, M.A., D.S. Jung and F.W. Bodyfelt. 1990. Influence of fat on the efficacy of nisin in inhibiting Listeria monocytogenes in fluid milk. J. Dairy Sci. 73(Suppl. 1):86.

William E. Sandine

Valyasevi, R., B.L. Geller, and W.E. Sandine. 1989. Characterization of bacteriophage receptors of lactic acid bacteria. J. Dairy Sci. 72(Suppl. 1).

Wyckoff, H.A., W.E. Sandine, and J.K. Kondo. 1989. Electroporation of *Leuconostoc* with plasmid DNA. J. Dairy Sci. 72(Suppl. 1).

Gary H. Richardson

Oberg, C.J., A. Wang, L.V. Moyes, and G.H. Richardson. 1989. Effect of proteolytic activity of thermolactic cultures on physical properties of Mozzarella cheese. J. Dairy Sci. 72(Suppl. 1).

Merrill, R.K., C.J. Oberg, R.J. Brown, and G.H. Richardson. 1990. Effect of milk coagulating enzymes on physical properties of Mozzarella cheese. J. Dairy Sci. 73(Suppl. 1):115

Rodney J. Brown

Mendenhall, I.V., R.J. Brown, and R. Grappin. 1990. Alternative wavelengths for infrared measurement of fat, proteins, and lactose in milk. J. Dairy Sci. 73(Suppl. 1):92.

Hollar, C.M., R.J. Brown, and J.F. Medrano. 1990. Quantification of casein genetic variants by RP-HPLC, PAGE, and amino acid analysis. J. Dairy Sci. 73(Suppl. 1):80.

Daren Cornforth

Dobson, B.N. and D.P. Cornforth. 1990. Effects of calcium caseinate, nonfat dry milk, and whey protein concentrate on color and texture of turkey rolls. Proceedings of 43rd Annual Reciprocal Meat Conference. Starkville, Mississippi.

Donald J. McMahon

B.J. Orme and D.J. McMahon. 1989. Effect of concentration on coagulation of ultrafiltered milk. 84th American Dairy Science Association Meeting, J. Dairy Sci. 72(Suppl. 1):184.

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McMahon, D.J., P.A. Savello, R.J. Brown, and M. Kalab. 1989. Microstructure differences in formation of a gel network in milk heated at high temperatures. The 1989 International Chemical Congress of Pacific Basin Societies. December 17-22, 1989. Honolulu, Hawaii.

Jeffery K. Kondo

Kondo, J.K., H.A. Wyckoff, and W.E. Sandine. 1989. Genetic manipulation of *Leuconostoc* for improved milk fermentations. Society of Industrial Microbiiology Annual Meeting (symposium), Seattle, WA.

Broadbent, J.R. and J.K. Kondo. 1990. Genetic construction of nisin-producing strains of *Lactococcus lactis* ssp. *cremoris*. J. Dairy Sci. 73(Suppl. 1):72.

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Floyd W. Bodyfelt

Beattie, S.E., W.E. Sandine, D.P. Selivonchick and F.W. Bodyfelt. 1990. Transformation of an omega-3 fatty acid producing fungus with LAC4 (β-galactosidase) of *Kluyveromyces lactis*. J. Dairy Sci. 73(Suppl. 1):71.

Feijoo, S.C. and F.W. Bodyfelt. 1990. A rapid method for determining proteases of heat resistant *Bacilli* in raw milk. J. Dairy Sci. 73 (Suppl. 1):101.

J. Antonio Torres

Martino, M., and Torres, J.A. 1990. Better utilization of cheese whey. Presented at the 79th Annual Oregon Dairy Industries Conference, Feb. 13-14, Eugene, OR.

Martino, M., Youssef-Hakimi, N., Daeschel, M.A., and Torres, J.A. 1990. Food grade stabilizer produced by *Lactobacillus plantarum* from acid whey. Presented at the 79th Annual Oregon Dairy Industries Conference, Feb. 13-14, Eugene, OR.

Martino, M. and Torres, J.A. 1990. Natural chitosan complexes: an alternative for the treatment of processing wastewater. Presented at the Pacific Fisheries Technologists Meeting, Feb. 18-21, Portland, OR.

Martino, M., Torres, J.A., Bodyfelt, F.W., and Daeschel, M.A. 1990. Characterization and isolation of a polysaccharide produced by *Lactobacillus plantarum* from acid whey. Paper no. 411. Institute of Food Technologists Annual Meeting, June 17-20, Anaheim, CA.

Martino, M., Bouzas, J., and Torres, J.A. 1990. Recovery of suspended solids from food processing wastewaters using chitosan-polyanion complexes. To be presented at the Sixth International Symposium on Agricultural and Food Processing Wastes, December 17-18, 1990, Chicago, IL.

Bouzas, J., Martino, M., and Torres, J. A. 1991. The use of chitosan-polyanion complexes for the treatment of food processing wastewaters. To be presented at the 5th International Conference on Chitin and Chitosan, October 17-20, Princeton, NJ.

Paul A. Savello

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Dargan, R.A., and P.A. Savello. 1990. Yogurt with improved physical properties from ultrafiltered and ultra-high temperature treated skim milk. J. Dairy Sci. 73(Suppl. 1): 111.

4. Faculty/staff working at the Center (list and assign FTE for each):

Principal Investigators	FTE
Mina R. McDaniel, OSU	.50
Lynn V. Ogden, BYU	.50
Joseph McGuire, OSU	.75
Mark A. Daeschel, OSU	.75
Floyd W. Bodyfelt, OSU	.90
W.E. Sandine, OSU	.77
J. Antonio Torres, OSU	.75
Paul A. Savello, USU	.70
Donald McMahon, USU	.70

Co-Investigators	FTE
Robert D. Sproull, Assistant Professor, OSU	.30
Kenneth R. Swartzel, Professor, NCSU	.10
Xintian Ming, OSU	.25
H.A. Wyckoff, OSU	.25
M. Barnes, OSU	.25
K. Gillies, OSU	.25
G.L. Geller, OSU	.25
R. Valyasevi, OSU	.25
Daniel P. Selivonchick, OSU	.25

Research Assistants	FTE
Nancy Michaels, OSU	1.00
Viwat Krisdhasima, OSU	1.00
Kamal Al-malah, OSU	1.00
Sidney A. Kirtley, OSU	1.00
Ja-Kael Luey, OSU	1.00
Prasert Sittiprasit, OSU	1.00
Jianguo Yang, OSU	1.00
Dong-Sun Jung, OSU	1.00
Sam E. Beattie, OSU	1.00
Sergio C. Feijoo, OSU	1.00
Miriam Martino, OSU	1.00
Mrudula Kalpalathicka,USU	.50
Craig Oberg, USU	.25

Graduate Students	FTE
Debbie L. Barnes, OSU	1.00
Steven J. Harper, OSU	1.00
Nilo Youssef-Hakimi, OSU	1.00
Richard Dargan, USU	1.00
Brian Orme, USU	1.00
Ivan Mendenhall, USU	1.00
Carole Hollar, USU	1.00
Richard Merrill, USU	1.00
James Yuan, USU	1.00
Amos Wang, USU	.50
Jeffrey Broadbent, USU	1.00
Rick Lord, BYU	.50

5. Research project reports (attach individual reports in format provided):

Attached

RESEARCH PROJECT
ANNUAL REPORT FORM

Annual Report Date (M/D/Y): June 30, 1990 Project Term (include dates): 7/1/87 - 6/30/91

Dairy Foods Research Center: Western

Dairy Center Director: Dr. J.K. Kondo

Principal Investigator: Gary H. Richardson

Project Title: Improvement of Mozzarella cheese yield and physical properties through proteinase modification of starter cultures

Project Status: Active

Project Summary:

1. Measurements of the physical properties of the curd will be used to establish differences among strains, culture pairs, and rod:cocci ratios.
2. The present stretch test will be evaluated to see if it provides the most accurate representation of stretchability.
3. Direct acid curd and curd from Prt^+ and Prt^- cultures will be compared at high pH values to evaluate the degree of stretchability and the stability of this property at refrigeration temperatures.
4. Direct acid cheese made with a variety of milk coagulating enzymes will be analyzed to determine the effect of these enzymes on the physical properties of Mozzarella cheese.

Project Results: Experiments were run comparing the helical viscometer and the Instron to measure stretch in Mozzarella cheese. The results were inconclusive. Six-liter vats of direct acid Mozzarella cheese were manufactured using either chymosin, bovine pepsin, porcine pepsin, or Mucor miehi protease. Four cheeses were made with each enzyme. Stretch using a helical viscometer, melt using a tube test, color using a reflectance colorimeter, moisture, and pH measurements were taken at 1, 7, 14, and 28 d during storage at 4°C. Analysis of variance and correlations were run on all parameters. Cook color was not affected by enzyme type but changed during storage time. Melt increased significantly with time, but was not affected by choice of enzyme. Moisture content of the cheese was not significantly affected by enzyme or by time. As melt increased over time, stretch decreased. The type of milk coagulating enzyme used in the manufacture of direct acid Mozzarella cheese played no role in development of the physical properties. Presently, Mozzarella cheese is being manufactured using various ratios of rods to cocci and the cheese is being evaluated for stretch, cook color, and melt. This study will be completed in the next two weeks. Mozzarella cheese is also being made with L. helveticus cultures and their affect on changes in physical is currently being measured.

Significance to the Dairy Industry: Proteinase negative starter cultures used in the production of Cheddar cheese, cottage cheese, and acid casein have been shown to increase yield, along with providing a number of other advantages. If proteinase negative cultures could be used in the production of Mozzarella and other high temperature Italian cheeses, an increase in yield may be possible. Additionally, if the effects of proteinase activity can be measured, there may be a possiblity of improvement in the stretching, along with other physical properties. The major purchasers of pizza cheese are concerned that the physical qualities of Mozzarella curd begin to deteriorate at about ten days of age. The proteolytic activity of

the starter culture is thought to be the cause of reduction of stretch. Buyers require that the curd be grated, frozen, and stored to maintain the young cheese qualities. By incorporation of less proteolytic thermolactic starter cultures, we desire to extend these superior qualities. The better and more consistent the physical properties, the more sales for the product.

Is Additional Effort or New Direction Needed Based on Project Findings:

NDPRB Action:

Publications:

Weimer, B.C., C.J. Oberg, L.V. Moyes, R.J. Brown, and G.H. Richardson. 1989. Comparison of classical ion exchange amino acid analysis and ophthaldioldehyde to characterize proteolysis by Lactobacillus bulgaricus. J. Dairy Sci. 72:2872.

Oberg, C.J., B.C. Weimer, L.V. Moyes, R.J. Brown, and G.H. Richardson. 1990. Proteolytic characterization of Lactobacillus delbrueckii spp. bulgaricus strains by amino acid analysis. J. Dairy Sci. (In press).

Oberg, C.J., A. Wang, L.V. Moyes, R.J. Brown, and G.H. Richardson. 1990. Effect of proteolytic activity of thermolactic cultures on physical properties of Mozzarella cheese. J. Dairy Sci. (In press).

Oberg, C.J., L.V. Moyes, and G.H. Richardson. 1990. Acid production of Lactococcus lactis ssp. cremoris in curd made at elevated temperatures. J. Dairy Sci. (submitted for publication).

Oberg, C.J., R. Merrill, L.V. Moyes, R.J. Brown, and G.H. Richardson. 1990. Effect of varied rod:cocci ratios of thermolactic cultures on physical properties of Mozzarella cheese. J. Dairy Sci. (in progress).

Merrill, R., C.J. Oberg, L.V. Moyes, R.J. Brown, and G.H. Richardson. 1990. Effect of Lactobacillus helveticus cultures on physical properties of Mozzarella cheese. J. Dairy Sci. (in progress).

Theses/Dissertations:

Abstracts:

Oberg, C.J., A. Wang, L.V. Moyes, and G.H. Richardson. 1989. Effect of proteolytic activity of thermolactic cultures on physical properties of Mozzarella cheese. J. Dairy Sci. 72 (Suppl. 1):(Abstr.).

Merrill, R.K., C.J. Oberg, R.J. Brown, and G.H. Richardson. 1990. Effect of ;milk coagulating enzymes on physical properties of Mozzarella cheese. J. Dairy Sci. 73 (Suppl. 1):115 (Abstr.).

Patents:

RESEARCH PROJECT
ANNUAL REPORT FORM

Annual Report Date (M/D/Y): June 30, 1990 Project Term (include dates): 7/87 - 6/91

Dairy Foods Research Center: Western

Dairy Center Director: Dr. J.K. Kondo

Principal Investigator: G.H. Richardson

Project Title: Improved Control of Cheese Manufacture Through Vat Monitoring

Project Status: Active

Project Summary:

1. Evaluate the control of curd strength during cottage cheese manufacture. Establish software that would be most helpful for the cheese industry.
2. Use the same system to monitor the coagulation of milk for Cheddar cheese manufacture. Determine acceptable limits of curd strength that would prevent the development of high moisture cheese due to late cutting or product losses due to early cutting of the curd. These data would then be applied to expert systems.
3. Determine abilities of chymosin, calcium salts, and lactic cultures in milk for Cheddar cheese to overcome the inability of milk from cows in late lactation to coagulate.
4. Compare the performance of proteinase negative lactic cultures when monitored by the system. Determine if they can perform at constant high cooking temperatures and if they confirm the observations of Linklater and Hall that culture volume is more important than temperature in pH control

Project Results: A hot wire coagulation probe (Snow Brand, Ltd., Japan) was configured with pH and temperature sensors. Milk substrate coagulation was monitored with this system and four other methods (Formagraph™, Sommer Matsen apparatus, Brookfield™ LVT viscometer, and an Omnispec™). The coagulation time of the hot wire probe was measured at maxima of the first and second derivatives. Coagulation times were compared using three repetitions with three levels of chymosin. The ability of each instrument to detect coagulation time varied from first to last: hot wire probe (2nd der. max.), Omnispec and the viscometer $p<.05$. The hot wire probe system was also used to monitor cheese manufacture in 300 kg batches. Temperature, pH, coagulation, cutting, healing, and stirring could all be detected with the monitor system.

Significance to the Dairy Industry: The data generated from such an instrument can be useful to provide improved control to every cheese vat. A curd cut time, based coagulation, pH and temperature could decrease losses and improve cheese yield and quality. The ability to measure the length of heal time and the rates of change of pH and temperature would also benefit the cheese manufacturer. Software programs could be included that would provide more management guidance. Significant savings to the industry could result when enzyme coagulant and other additive costs can be reduced by fine tuning the process through continuous monitoring of the milk in the cheese vat.

Is Additional Effort or New Direction Needed Based on Project Findings:

NDPRB Action:

RESEARCH PROJECT
ANNUAL REPORT FORM

Annual Report Date (M/D/Y): May 10, 1990 Project Term (include dates): 7/1/88 - 12/31/90

Dairy Foods Research Center: Western

Dairy Center Director: Dr. J.K. Kondo

Principal Investigator: J.A. Torres, F.W. Bodyfelt and Conly Hansen

Project Title: Cheddar cheese blocks: Effect of cheese composition and cooling methods

Project Status: Active

Project Summary: A consistent quality can only be achieved if manufacturing procedures are as controlled as possible. Unfortunately, there is still a wide variation in the sensory properties of Cheddar cheese. Experienced cheese graders frequently categorize 30-40% of all American Cheddar cheese as being "high acid (sour)" or "bitter" in off-flavor. Our research efforts are concentrated on the effect of the block cooling rate and maturation temperature on the chemical, microbiological and sensory properties of Cheddar cheese. This information is used in conjunction with a determination of the engineering properties of Cheddar cheese to guide the selection of temperature conditions that favor a more uniform and desirable product quality.

Project Results: The experimental procedures used in this research were developed primarily to accommodate the wide range of temperature effects to be covered (5-35°C) and the large experimental error associated with sensory analysis. Samples were drawn from commercial production after the pressing step in the process used at Tillamook County Creamery Assoc. (Tillamook, OR). Blocks were cut and vacuum wrapped under sanitary conditions. Samples were small enough to reach storage temperature within 1-2 hours. The experimental design includes two batches with two replicates stored at 5, 15, 25, and 35°C with results of the effect on the sensory and microbial parameters reported last year. An additional four batches with one replicate have been tested this second year. Sensory and microbial analysis of these samples have been completed. Chemical analysis is underway and will be completed summer 1990. Engineering and modeling efforts will completed by December 1990.

Significance to the Dairy Industry: American is the major type of cheese produced in the United States - the vast majority of this is Cheddar cheese. We believe that Cheddar cheese sales could increase if there was less variability in product quality. The economical impact of current variability is enormous because much Cheddar cheese has to be marketed at a younger age than is perhaps optimal for best price. The frequency of the sourness/bitterness defect reduces its quality image, reduces its market value and also limits its overall consumer acceptance (sales volume).

Is Additional Effort or New Direction Needed Based on Project Findings: No new direction is needed at this time.

NDPRB Action:

RESEARCH PROJECT
ANNUAL REPORT FORM

Annual Report Date (M/D/Y): June 30, 1990 Project Term (include dates): 11/88-12/91

Dairy Foods Research Center: Western

Dairy Center Director: Dr. J. Kondo

Principal Investigator: Dr. J.A. Torres
Dr. C.L. Hansen

Project Title: Cooling rate of Cheddar cheese: Comparison between 40 and 640 lb blocks and uniform cooling of 640 lb blocks.

Project Status: ACTIVE

Project Summary: Objectives: 1) Determine the thermal conductivity of fresh Cheddar cheese curd and compare the value with the thermal conductivity of aged Cheddar cheese.
2) Characterize the link between moisture movement within large Cheddar cheese blocks to the cooling rate of the block.

Project Results: Computer programs have been written to model the temperature profile in rectangular and cylindrical blocks under standard and modified cooling conditions. Data has been collected on a three large rectangular blocks and one cylindrical cheese block. Plots of the actual temperature have been compared to the model data to analyze deviations from theoretical expectations. Preliminary analysis shows good correlation between model and actual data. Thermal conductivity tests are underway at the present time.

Significance to the Dairy Industry: To establish whether or not moisture movement in large Cheddar cheese blocks is directly caused by cooling rate. If this is the case, then a method of cooling the blocks at a faster rate could be developed which would lead to consistent high quality Cheddar cheese.

Is Additional Effort or New Direction Needed Based on Project Findings: Not at this present time.

NDPRB Action:

RESEARCH PROJECT
ANNUAL REPORT FORM

Annual Report Date (M/D/Y): June 30, 1990 Project Term (include dates): 7/1/89 - 6/30/91

Dairy Foods Research Center: Western

Dairy Center Director: Dr. J.K. Kondo

Principal Investigators: Drs. J.A. Torres, M.A. Daeschel, and F.W. Bodyfelt

Project Title: Acid whey utilization: Functional properties of a food grade stabilizer produced by *Lactobacillus plantarum* from acid whey

Project Status: Active

Project Summary: Acid whey, characterized by its high lactose content and low pH, constitutes a serious waste disposal problem to the dairy industry. Direct fermentation of acid whey by Lactobacillus plantarum 304 yielded highly viscious solutions. The polysaccharide(s) responsible for this behavior are being quantified and optimized, and their functional properties evaluated.

Project Results: Model studies (modified MRS with various sugar sources) were conducted to determine the effect of sugar source and temperature on bacterial growth and polysaccharide production. A polysaccharide isolation and purification technique was also developed. Aqueous solutions of the isolated polysaccharide, 0.1 - 5% w/v, exhibited low viscosity pseudoplastic behavior. Attempts to stabilize the viscious behavior observed in the fermentation broth, e.g. by addition of divalent salts (Ca^{++}), were only partially successful. Finally, oil/water emulsions prepared with and without added purified polysaccharide showed that the polysaccharide has emulsion stabilization properties. Surface tension measure measurements will be made to evaluate the use of the polysaccharide as a emulsifying agent not increasing food viscosity.

HPLC analysis indicate the presence of glucose and galactose as the main sugar components of the polysaccharide. Reaction with Ca^{++} highlights the polyanionic character of the polysaccharide. The formation of polymeric complexes, by reaction with chitosan (a "natural" polycation) opens the possibility of developing "natural" coagulating agents for the treatment of food processing wastewater. The coagulated material could be used as an animal feed component. The polysaccharide + chitosan complex reaction can be controlled by adjusting reaction pH conditions to yield complexes with the charge ratio needed for the wastewater stream to be treated.

Significance to the Dairy Industry: A major problem faced by today's dairy industry is to find profitable uses for whey. In spite of new uses, whey utilization remains around 50%. The rest is discharged with a continuously increasing disposal cost. The production of polysaccharides with functional properties of commercial interest uses a waste to generate a by-product with commercial value.

Is Additional Effort or New Direction Needed Based on Project Findings: The use of the polycation (chitosan)-polysaccharide complex constitutes a new alternative to recover proteins from acid whey and other dairy waste streams. A treatment process could therefore involve the production of a "natural" emulsifying agent by fermentation of acid whey after recovery of the whey protein fraction using the complex as a coagulating agent. This process would utilize both the lactose and the protein whey fractions.

NDPRB Action:

RESEARCH PROJECT
ANNUAL REPORT FORM

Annual Report Date (M/D/Y): June 30, 1990 Project Term (include dates): 8/1/87 - 6/30/90

Dairy Foods Research Center: Western

Dairy Center Director: Dr. J.K. Kondo

Principal Investigator: Arthur W. Mahoney

Project Title: Iron Fortification of Cheese Curd

Project Status: Inactive

Project Summary:

1. To evaluate effects of 12 months aging on quality of iron fortified cheeses prepared in the last few months of the current project.
2. To determine the iron binding characteristics of iron-casein, ferripolyphosphate whey protein (FIP-WP) and Fe-whey protein (Fe-WP) complexes prepared with different iron concentrations.
3. To determine the effects of iron fortification with 'optimized' iron-protein complexes on cheese quality.
4. To determine the effects of iron fortification on the quality of process cheddar cheese.
5. To determine the bioavailability of iron in the 'optimized' iron-protein complexes as well as cheese fortified with them.

Project Results: Iron fortification did not affect the quality of Cheddar cheese in our previous study and of process cheese in this study although some differences exist between these two cheeses. For Cheddar cheese, milk coagulation is involved, heating is at low temperature, pH is low, and microbial organisms from the starter culture are still growing during the aging period. In contrast, for process cheese, a relatively high temperature is applied, pH is high, and other ingredients are added to the cheese. However, they both have high protein contents which may act as a chelator of iron. This may be the main reason that low lipid peroxidation was observed in both kinds of iron fortified cheeses. Another reason for low lipid peroxidation may be the saturation of the fat. Milk fat contains mostly saturated fatty acids, 30% of the fatty acids are unsaturated of which about 3% are polyunsaturated. Also, for lipid peroxidation to occur, both Fe^{2+} and Fe^{3+} are required with maximal rates of lipid peroxidation at the ratio of Fe^{2+} and Fe^{3+} being approximately one. However, it is unlikely that iron bound to milk protein is free to change its oxidation state at the pH of cheese. Therefore, the conditions are favorable for iron fortification of cheese products.

Significance to the Dairy Industry: Iron fortified dairy products could be promoted for increasing the iron density of the low-iron diets as well as calcium and vitamin D contents thereby addressing two major nutritional concerns of women and children: i.e., iron deficiency (women, children under age 2 and elderly men) and osteoporosis (middle-aged women, growing children and elderly men). Young children and teenagers enjoy process cheese, making iron fortified process cheese more meaningful to target this population in prevention of iron deficiency. Fortified process cheese would be expected to contribute relatively more benefit to children and teenagers who are at risk of iron deficiency, because they eat more process cheese than other segments of the populations. Iron fortification of

process cheese improves this product nutritionally from almost no iron to an iron-rich food, 11 mg/100 kcal.

Is Additional Effort or New Direction Needed Based on Project Findings:

NDPRB Action:

Publications:

Zhang, D. and A.W. Mahoney. 1989. Effect of iron fortification on quality of Cheddar cheese. J. Dairy Sci. 72:322.

Zhang, D. and A.W. Mahoney. 1989. Bioavailability of iron-milk-protein complexes and fortified Cheddar cheese. J. Dairy Sci. 72:2845.

Zhang, D. and A.W. Mahoney. 1990. Effect of iron fortification on quality of Cheddar cheese. II. Effects of aging and fluorescent light on pilot scale cheeses. J. Dairy Sci. In press.

Zhang, D. and A.W. Mahoney. 1990. Iron fortification of process Cheddar cheese. Submitted to J. Dairy Sci.

Theses/Dissertations:

Abstracts:

Patents:

RESEARCH PROJECT
ANNUAL REPORT FORM

Annual Report Date (M/D/Y): July 30, 1990 Project Term (include dates): 07/01/87-6/30/90

Dairy Foods Research Center: Western

Dairy Center Director: Dr. J.K. Kondo

Principal Investigator: Dr. Daren Cornforth

Project Title: Evaluation of milk proteins as whitening agents in processed meat and poultry products

Project Status: Terminated

Project Summary: To determine the effects of various milk proteins (3% calcium caseinate, non-fat dry milk (NFDM), or whey protein concentrate (WPC)) on color, texture and panel acceptability of turkey rolls containing 10 or 30% turkey thigh meat. The turkey rolls were evaluated by a trained sensory panel (21 panelists) and by instrumentation. Color intensity, color uniformity, cohesiveness, tenderness, flavor, juiciness and overall acceptability were evaluated on a 8 point scale, where 7 was high and 1 was low for each attribute. The study was repeated three times.

Project Results: Controls (no milk proteins) and rolls formulated with NFDM or WPC were rated significantly higher than rolls containing caseinate for color uniformity, cohesiveness, flavor and overall acceptability. Rolls containing caseinate were significantly darker than controls or rolls with WPC. Panelists detected no significant differences among milk protein treatments for juiciness or toughness. Rolls made with milk proteins had significantly higher cooked yields (89%) than control rolls (86%).

In conclusion, milk powders containing lactose (NFDM and WPC) increased the yield and cohesiveness of turkey rolls. Color was unaffected, compared to controls. Turkey rolls made with calcium caseinate also increased yield compared to controls, but the rolls had poor texture and insufficient cohesiveness.

Significance to the Dairy Industry: Turkey rolls and other precooked meat items such as ham, bacon, or roast beef usually contain 0.5% phosphate to increase the cooked yield and product cohesiveness. Results of this study showed that addition of 3% NFDM or WPC increased yield and improved texture of turkey rolls, even in the absence of phosphate. Calcium caseinate addition increased yield, but texture was poor. NFDM or WPC are both over 50% lactose. Calcium caseinate contains no lactose. It thus appears that lactose is the substance that improves texture of turkey rolls.

Phosphates are not permitted in some cooked meat products in Europe or Japan. Thus there is great interest in substitutes for phosphates in precooked meats. Based on results of this study, both NFDM and WPC have potential to replace phosphate in precooked meats.

Caseinates have been the most widely promoted milk powder for use in meat products. Results of this study show that lactose-containing NFDM and WPC were actually superior to calcium caseinate in a cooked turkey roll. Thus there is great potential for increased use of NFDM, WPC, and lactose in precooked poultry products.

Is Additional Effort or New Direction Needed Based on Project Findings: NFDM and WPC are good meat binders. NFDM, WPC and lactose alone should be evaluated as binders in low fat franks, and pre-cooked for meat products.

NDPRB Action:

RESEARCH PROJECT
ANNUAL REPORT FORM

Annual Report Date (M/D/Y): June 30, 1990 Project Term (include dates): 8/01/87-12/31/90

Dairy Foods Research Center: Western

Dairy Center Director: Dr. J. Kondo

Principal Investigator: Floyd W. Bodyfelt

Project Title: Rapid Assay for Heat Resistant Microbial Proteases in Raw Milk by a Simple Casein Denaturation Method

Project Status: ACTIVE

Project Summary: 1. Develop a diffusion casein-agar test capable of quantitating the proteolyte activity exhibited by heat resistant sporeforming bacteria (Bacillus sp.) in either raw or pasteurized milk samples that have been subjected to a standardized heat treatment. 2. Determine the optimal conditions for: (1)the initial heat treatment (standardized) of milk samples, (2)preliminary incubation conditions, and (3)other necessary assay parameters. 3. Determine the most appropriate casein fracti and the optimal buffering and suspension systems for the substrate matrix for conduct of the proteinase assay. 4. Develop and alternative method for determining populations of Bacillus sp. in selected raw milk samples by a combination of preliminary incubation and a dye reduction test.

Project Results: A sensitive diffusion casein-agar method was developed to detect the proteolytic activity exhibited by heat resistant sporeforming bacteria (Bacillus sp.) in raw milk. Initial experiments demonstrated Beta-casein to be the preferred substrate for assessing proteinase activity of Bacillus sp. Optimum test parameters for proteinase assays were determined. The extent of proteinase activity was proportional to the relative zone size of casein precipitation, which closely correspond with the magnitude of milk sample spore and psychrotrophic spore counts.

Significance to the Dairy Industry: Conservatively, assuming that approximately one fourth of all milk producers incur higher than desirable Bacillus sp. counts, there may be no bette way to focus on this ubiquitous milk quality problem than to develop a rapid, routine test method for screening milk samples for this troublesome microflora. Such a reliable and feasible analytical tool could be an invaluable step forward for enhancing milk quality at the farm level. An effective tool for rapid and accurate detection of Bacillus sp. could serve as a keystone test within milk quality incentiv programs for the U.S. dairy industry.

Is Additional Effort or New Direction Needed Based on Project Findings: The plate-well diffusion assay for Bacilli proteinase activity developed through this project appears to be sensitiv simple, economical and reliable. There is a need to demonstrate its applicability within dairy processor laboratories.

NDPRB Action:

RESEARCH PROJECT
ANNUAL REPORT FORM

Annual Report Date (M/D/Y): June 30, 1990 Project Term (include dates): 1/1/88-12/31/90

Dairy Foods Research Center: Western

Dairy Center Director: Dr. J.K. Kondo

Principal Investigator: Joseph McGuire

Project Title: Characterization of the Post-Adsorptive Behavior of Beta-Lactoglobulin for Control of Spore and Microbial Adhesion to Dairy Product Processing and Packaging Surfaces

Project Status: Active

Project Summary: It is the purpose of this research to use ellipsometry in an effort to quantify the post-adsorptive behavior of Beta-lactoglobulin on several materials as a function of time and contact surface properties. An understanding of this relationship should provide direction for the control of surface phenomena including bacterial biofilm development.

Project Results: We have constructed Beta-lactoglobulin adsorption isotherms on acrylic, glass, polycarbonate, polyester, and #304 stainless steel surfaces. Additionally, hyperpure silicone surfaces have been modified to be hydrophilic or hydrophobic; Beta-lactoglobulin adsorption isotherms have been constructed on each of these surfaces as well. The influence of pH, ionic strength, and temperature on Beta-lactoglobulin adsorption equilibrium behavior has also been investigated. In general, the amount of protein adsorbed at a surface was observed to increase with increasing surface hydrophobicity at all combinations of pH and ionic strength investigated. Moreover, these tests indicated that non-electrostatic interactions between the surface and protein dominate the adsorption process at hydrophobic surfaces, while electrostatic interactions dominate the process at hydrophilic surfaces.

Significance to the Dairy Industry: Biofilm formation on dairy processing surfaces presents a serious impediment to consistently providing wholesome, high quality milk products, and is suggested to be dependent upon the presence and conformational state of a pre-adsorbed, proteinaceous conditioning film on the contact surface. A quantitative understanding of contact material surface properties and their relationship to the initial surface-protein and subsequent protein-microbe interactions associated with biofilm development will provide powerful direction for control of biofilm formation.

Is Additional Effort or New Direction Needed Based on Project Findings: Yes

NDPRB Action:

McGuire, J. and S.A. Kirtley. Surface Characterization for Prediction of Food Particle Behavior at Interfaces: Theoretical Considerations and Limitations. *Journal of Food Engineering*. 8: 273-286. 1988.

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McGuire, J. and S.A. Kirtley. On Surface Characterization of Materials Targeted for Food Contact. *Journal of Food Science*. 54: 224-226. 1989.

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Abstracts

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Krisdhasima, V., R.D. Sproull and J. McGuire. Application of Ellipsometry to the Study of Food Protein Behavior at Interfaces. Paper no. 702, IFT Annual Meeting, Chicago, IL. 1989.

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Al-malah, K. and J. McGuire. Application of Ellipsometry to the Characterization of Milk Soils on Fouled and Cleaned Surfaces. Paper no. 39, IFT Annual Meeting, Anaheim, CA. 1990.

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Krisdhasima, V., J. McGuire and R.D. Sproull. Surface-Induced Conformational Changes Experienced by β-lactoglobulin at Hydrophilic and Hydrophobic Surfaces, to be presented at the AIChE Summer National Meeting, San Diego, CA. 1990.

Wang, D.Q., E.R. Kolbe, J. McGuire and R.D. Sproull. Kinetic Analysis of Freeze Denaturation of Pacific Red Rockfish Myofibrillar Protein Using DSC, to be presented at the AIChE Summer National Meeting, San Diego, CA. 1990.

RESEARCH PROJECT
ANNUAL REPORT FORM

Annual Report Date (M/D/Y): May 15, 1990 Project Term (include dates): 7/88-6/90

Dairy Foods Research Center: Western

Dairy Center Director: Dr. J. Kondo

Principal Investigator: Dr. Lynn V. Ogden

Project Title: Method of Identifying Batch of Origin in Semi-Continuous Cheese Processes.

Project Status: Terminates on June 30, 1990

Project Summary: The feasibility of using minimal color variations in alternate batches and on-line colorimetry to detect the seams between batches was investigated as a means of determining the batch or origin in semi-continuous cheese processes. Four vegetable colors were investigated in small laboratory batches using the Hunte Labscan 2. Amounts of color addition necessary for a detectable colorimetric difference and resulting relative visual difference were determined. A plant trial was conducted varying the amount of annatto in alternate batches.

Project Results: In lab trials, turmeric was the most sensitive marker and canthaxanthan th least sensitive with annatto and beta carotene in the middle. A 19% change in annatto usage was found to be necessary to detect the change colorimetrically usin the Hunter b value. Nine and sixteen percent changes in annatto were tried in a plant trial using Yellow Index, Hunter b values, and the Hunter Qual probe as colormetric measures. Colorimetric an visual sensitivity to these variations is being analysed.

Significance to the Dairy Industry: Accurate determination of batch of origin is needed in semi-continuous cheese processes to confine downgrading to only that cheese produced in defective batches. Currently the equivalent of three batches are downgraded to assure that all one defective batch is included.

Is Additional Effort or New Direction Needed Based on Project Findings: A recommendation will be made July 1990.

NDPRB Action:

RESEARCH PROJECT
ANNUAL REPORT FORM

Annual Report Date (M/D/Y): June 30, 1990 Project Term (include dates): 7/1/88-4/30/91

Dairy Foods Research Center: Western

Dairy Center Director: Dr. J.K. Kondo

Principal Investigator: Rodney J. Brown

Project Title: Application of Fourier Transform Infrared Technology to Infrared Technology to Milk and Dairy Products

Project Status: Active

Project Summary: This project has a long series of specific objectives that lead to the ability to rapidly measure fat, protein, lactose, moisture, and fat saturation level in milk and dairy products. These specific objectives must be accomplished in a logical order:

1. Find a set of wavelengths in the infrared spectrum that respond to changes in fat, protein, and lactose concentrations.
2. Find a set of wavelengths in the infrared spectrum that do not respond to changes in saturation level, chain length, and level of free fatty acids.
3. Combine (1) and (2) to make a robust set of wavelengths common to all constraints.
4. Determine the individual spectra and common wavelengths to milk fat, protein and lactose.
5. Find a set of wavelengths common to the milk components (4) and to the robust set (3).
6. Statistically calibrate for testing samples of unknown composition using only this set of wavelengths (9) and milk samples chemically tested for fat, protein, lactose, and moisture. (Less than 1600 cm^{-1} wavenumber should be used if possible.)
7. Calibrate, using wavenumbers greater than 2700 cm^{-1}, to determine saturation level of fat in dairy products (especially cheese).

Project Results: To identify wavelengths which respond to changes in fat concentration, we prepared a series of milk samples where the fat level varied and all other components were held constant. The correlation coefficient for absorbance and fat concentration was calculated at each wavelength. A similar experiment was performed to determine wavelengths that linearly respond to changes in protein concentration. To determine wavelengths that linearly respond to changes in lactose concentration, a series of lactose solutions were prepared where the lactose concentration varied from 1 to 5.5%. We then selected wavelengths which were responsive to fat, protein, and lactose concentrations, and relatively unaffected by saturation, chain-length, and lipolysis. Nine calibration standards (each composed of milk from a separate herd) were purchased. The FTIR was calibrated using these standards and Partial Least Squares (PLS) statistics. The concentration of fat, protein, and lactose in these samples was then predicted using the generated calibration equations. The standard deviations of difference between chemical and predicted values lie close to the AOAC recommended SD of .06%. This data was obtained with no homogenation or temperature control. A liquid ATR cell was used and 64 scans at 4 cm^{-1} resolution were averaged to obtain each sample spectrum.

Significance to the Dairy Industry: This project will provide an improved method for measuring fat, protein, lactose and water content in dairy products. A fast method for detecting non-dairy ingredients, particularly fat, in products labeled or sold as dairy products is needed. Adulterated products sold as dairy products replace real dairy products. The large number of measurements possible in a short time allows much more powerful data processing methods to be used. Any number or combination of readings can be used to measure any component. An FTIR instrument can consider variables such as saturation level of the fat, lipolysis of fat, etc. so they do not interfere with accurate measurements. Calibration of the instruments will be less frequent.

Is Additional Effort or New Direction Needed Based on Project Findings:

NDPRB Action:

Publications:

Theses/Dissertations:

Abstracts:

Mendenhall, I.V., R.J. Brown, and R. Grappin. 1990. Alternative wavelengths for infrared measurement of fat, proteins, and lactose in milk. J. Dairy Sci. 73 (Suppl. 1):92.

Patents:

RESEARCH PROJECT
ANNUAL REPORT FORM

Annual Report Date (M/D/Y): June 30, 1990 Project Term (include dates): 7/88 - 6/91

Dairy Foods Research Center: Western

Dairy Center Director: Dr. J.K. Kondo

Principal Investigator: Rodney J. Brown

Project Title: Estimation of Individual Milk Proteins and Genetic Variants by Multicomponent Analysis of Amino Acid Profiles

Project Status: Active

Project Summary:

1. Determine concentrations of groups of proteins in milk such as caseins or whey protein using amino acid analysis.
2. Determine concentrations of specific milk proteins; αs1, αs2, β, and κ-caseins, α-lactalbumin, β-lactoglobulin, bovine serum albumin using amino acid analysis.
3. Separate genetic variants of specific milk proteins, and use amino acid analysis to quantify individual variants in a protein mixture.
4. Use techniques developed in 1-3 analyze milk and other dairy products.
5. Determine mathematical procedures to obtain the most accurate and reproducible methods for estimating milk protein concentrations.

Project Results: Stepwise regression was used to predict whether a given variant was present in 0, 1 or both alleles based on normalized amino acid concentrations. An R^2 or .83 was obtained using 12 amino acids for predicting the presence of κ-casein A or B as shown here. Amino acid analysis was not as good at predicting the β-casein variants present. The R^2 values obtained reflect, in part, the use of casein genetic variant mixtures being used to predict whether no, one or both alleles contained a given casein variant. In addition, Van Eenennaam and Medrano dealing with κ-cas suggest that the two alleles of each casein may not be expressed equally. One allele may dominate which could also influence the ability of amino acid analysis to identify the presence and degree to which a variant is present.

The RP-HPLC procedure used may work to identify and quantify some of the casein genetic variants with further refinements. Previous amino acid analysis research has shown it can be used to predict the percentage of the various caseins present in a mixture. We did have limited success in predicting the -casein variant present and to a lesser extent the β-casein variants.

Significance to the Dairy Industry: The goal of this project is to determine proportions of specific milk proteins (down to the level of specific genetic variants) or groups of proteins in milk and other dairy products from the information contained in a single amino acid analysis of a sample. Relative proportions of milk proteins found in traditional dairy products are subject to change as ultrafiltration and other new processes ar used in their manufacture. To use these emerging manufacturing processes to produce entirely new products without the information that will be made available when this project is completed is nearly impossible. Many areas of research will also be facilitated by the results of this research. We will be able to follow milk protein composition through lactation periods of individual cows (or other species), correlate content of each of the milk proteins with coagulation properties during cheese making, make artificial infant formula that more closely matches mothers' milk, etc.

Is Additional Effort or New Direction Needed Based on Project Findings:

NDPRB Action:

RESEARCH PROJECT
ANNUAL REPORT FORM

Annual Report Date (M/D/Y): June 30, 1990 Project Term (include dates): 10/88-6/30/91

Dairy Foods Research Center: Western

Dairy Center Director: Dr. J.K. Kondo

Principal Investigator: Dr. Arthur W. Mahoney

Project Title: Evaluation of Iron-Protein Complexes in Iron-Fortified Dairy Products

Project Status: Active

Project Summary:

1. To determine the nature of the basic interaction of individual milk proteins with ferrous/ferric iron in simple buffer systems.
2. To study the effect of pH, temperature and ionic strength on the iron-protein complex formation.
3. to determine the effect of iron binding on self-association of individual proteins and/or protein cross binding.
4. To characterize the iron-protein complexes in Jenness-Koops buffer (simulated milk salt buffer) using individual proteins as well as casein micelles and determine their stability.
5. To study the effect of iron binding to K-Casein and casein micelles on the rennin hydrolysis of the phe-met bond of K-Casein and subsequent coagulation of casein micelles.
6. To test the iron-protein complex formation in milk systems.
7. To determine the catalytic potency iron-protein complexes on oxidative damage to model lipids and to lipids in milk, yoghurt and cheese systems.

Project Results: We have now developed the necessary methods and standardized conditions for testing iron binding to milk proteins in this laboratory. Therefore, we are poised to make excellent progress toward understanding iron chemistry of fortified cheese and other milk products. Gel filtration and diafiltration were tried and the latter method was found to be satisfactory owing to the shorter time duration (4 to 5h) required to complete a binding experiment. Various iron salts were screened for their suitability in iron-protein binding experiments. Ferrous sulfate was not suitable due to rapid oxidation of the iron to the ferric state and precipitation. Ferric chloride underwent hydroxylation at pH 6.60 leading to the formation of insoluble $FeOH)_3$ polymers which did not pass through the ultrafiltration membrane. Ferric nitrilotriacetic acid, Fe(III)NTA, prepared by adding solid ferric nitrate to a solution of sodium NTA (molar ration of Fe:NTA of 1:2) was found suitable for iron binding studies. Fe(III)NTA did not form polymers at pH 6.60 and freely through the PM-10 ultrafiltration membrane.

Significance to the Dairy Industry: Iron fortification would increase the iron intakes of people who consume large amounts of dairy products, and it would allow people who are concerned with their iron nutritute to consume larger amounts of dairy products to achieve greater dietary calcium intakes. Thus, dairy products would be even more healthful in the diet if iron-fortified. This research will provide basic information on the mechanisms of iron binding in dairy products, information essential to industrializing the technology of fortifying dairy products with iron.

Is Additional Effort or New Direction Needed Based on Project Findings:

NDPRB Action:

RESEARCH PROJECT
ANNUAL REPORT FORM

Annual Report Date (M/D/Y): May 31, 1990 Project Term (include dates): 7/88-6/90

Dairy Foods Research Center: Western

Dairy Center Director: Dr. J. Kondo

Principal Investigator: Mina R. McDaniel

Project Title: Optimization of the Sensory Qualities of Flavored Yogurt

Project Status: Incomplete, but no longer funded

Project Summary: In an attempt to increase yogurt sales by raising consumer acceptance, both consumer and descriptive panels were utilized to characterize and evaluate sensory attributes in flavored and plain yogurt. Correlation of results from both panels with analytical measurements (i.e. pH, titratable acidity, HPLC) will provide information for product improvement. Given this directional information, formula optimization work could be completed.

Project Results: Large differences were found by both panels for all yogurts evaluated. Consumer overall liking was determined by liking of flavor, sweetness, and sourness. Bitterness tended to reduce acceptance of flavored yogurts. For strawberry yogurt, sweetness/sourness ratios needed to be greater than 1.0 for high consumer acceptance, and plain yogurt attributes such as acetaldehyde, sourness, and astringency strongly opposed sweetness attributes. Definite male and female differences were also found.

Significance to the Dairy Industry: This study demonstrated that there were very large difference in acceptability among the commercial samples tested for all yogurt flavors evaluated. These findings have suggested that there is a definite need for optimization work, and there is sufficient room for improvement of the sensory qualities of yogurt. If optimization work could continue, it is very possible that we could find some easy formulation changes that would improve yogurt quality and increase consumer acceptability, ultimately leading to increased yogurt sales.

Is Additional Effort or New Direction Needed Based on Project Findings: Yes, additional effort is needed to complete this project. Based on the large differences found, optimization work should be completed to determine changes needed to increase consumer acceptance.

NDPRB Action:

RESEARCH PROJECT
ANNUAL REPORT FORM

Annual Report Date (M/D/Y): June 30, 1990 Project Term (include dates): 8/88-6/91

Dairy Foods Research Center: Western

Dairy Center Director: Dr. J.K. Kondo

Principal Investigator: Paul A. Savello

Project Title: Properties of Low-Fat Yogurt Manufactured from Ultrafiltered and Ultra-High Temperature Treated Milk

Project Status: Active

Project Summary: This project is investigating the effects of ultrafiltering milk to different total milk solids levels and applying different heat treatments on yogurt properties (viscosity, gel strength, syneresis, and water holding capacity). Structural differences will be observed by scanning and transmission electron microscopy. The effect on acidification time to desired gelation level by differently treated yogurt milks (concentration and heat treatment) will be measured. The acceptability of yogurt flavor and texture by appropriate taste panel procedures will be determined of the variously treated yogurt samples.

Project Results: Using ultrafiltration to increase solids affords greater viscosity, gel strength, WHC, and lower syneresis in UHT yogurt as compared to vat heated yogurt with added NFDM to comparable solids levels. Increasing UHT temperature (especially 280° F) does not improve gel strength, viscosity, WHC, and syneresis. Rather, lower temperatures (220-240° F) provide the greatest viscosity, gel strength, WHC, and less syneresis (especially when solids are increased by UF). Intermediate UHT treatment may provide comparable or better WHC and improved syneresis as compared to vat-heated yogurt, but this effect becomes less distinguishable as solids are increased by UF (both heating methods are good). However, UHT treatment does not appear to be able to match the same levels of gel strength and viscosity that can be seen with vat heat treatment.

Significance to the Dairy Industry: Increasing the total milk solids by ultrafiltration appears to be a good means for improved yogurt physical characteristics. Measurements of these yogurt flavor and texture attributes must still be studied.

Is Additional Effort or New Direction Needed Based on Project Findings: Yes

NDPRB Action:

RESEARCH PROJECT
ANNUAL REPORT FORM

Annual Report Date (M/D/Y): June 30, 1990 Project Term (include dates): 9/1/88 - 8/31/91

Dairy Foods Research Center: Western

Dairy Center Director: Dr. J.K. Kondo

Principal Investigator: Dr. D.J. McMahon

Project Title: High Yield, Low Moisture Cheese from Homogenizd Ultrafiltered Milk

Project Status: Active

Project Summary: Ultrafiltration (UF) of milk can be used for the manufacture of high moisture cheeses. There are, however, some difficulties and complexities of making low moisture cheese using UF concentrated milk in that high fat losses occur and it is difficult to remove moisture. The specific objectives of this project are:

1. Determine effects of homogenization treatment on fat losses from UF retentate curd.
2. Design a cheese making process so as to obtain cheese in the range of pH 5.0—5.4 and moisture content < 40%.
3. Determine effects of milk heat treatment on moisture, texture and body of cheese made from UF retentate.
4. Provide a manufacturing procedure for making acceptable low moisture cheese from pre-fermented UF retentate that could be adopted for a continuous cheese making process.

Project Results:

Objective 1: Homogenization and Fat Loss.

Experiments have been conducted to determine effects of homogenizing whole milk on the extent of fat/casein complexing that occurs and the subsequent retention of fat in cheese curds made from 5X UF retentate. Pasteurized whole milk was divided into two lots and one lot homogenized at 3500 psi, while the other was not homogenized. Both lots were ultrafiltered without diafiltration to 38% solids. Cheeses were made simultaneously from 3.5 kilogram batches of retentate from each lot using standard cheddar make parameters. A one half kilogram, pH 5.0 water overlay, was used to float curds. Over the course of agitating and cooking curds to 39°C, a 1 cm deep free-fat layer developed in whey from the unhomogenized sample, while whey from the homogenized sample contained only a discontinuous film of free-fat. Final moisture levels were high, that is, in the range of 42—43% but homogenization did not significantly affect final moisture. On this visual basis, homogenization shows promise for increasing fat retention of UF retentates.

Objective 2: Cheese making Process

Our experiments have shown that less rennet is required to coagulate 5X retentates if pH is below 6.4. UF retentates are also much less viscous and more easily handled if they have been adjusted to pH 6.4—6.0. We have considered that if retentates were pre-fermented to pH 6.4 at approximately 30°C, temperature could then be reduced to 20°C to slow acid production and provide a larger make–window. If retentates were renneted and cut at 20°C, curds could be cooked over a 19C° range instead of a 9C° range to increase syneresis. Experiments to determine the effect of this procedure on cheese moisture are beginning.

Objective 3: Milk Heat Treatment

Work on this objective will not be undertaken until objectives 2 and 3 are completed.

Objective 4: Cheese Quality

Textures and microstructures of cheese made from UF retentate differ from those of traditionally-made cheese. Studies made in our laboratory have shown that coagulation of milk normally occurs when hydrolysis of κ-casein is 80—90% complete. However, when milk is concentrated to 5X, coagulation occurs when only 50—60% of κ-casein is cleaved. This compression of the enzymic and aggregation phases of coagulation may in part be responsible for different curd structure and final properties of UF cheese. By lowering coagulation temperature, there is a marked slowing of aggregation rate. This slowing of aggregation rate relative to proteolysis should provide a more natural curd texture in the final cheese.

Significance to the Dairy Industry:

UF has been of only limited use in the manufacture of low moisture cheeses because concentration of milk in most UF systems reaches a limit at approximately 40% total solids. UF retentate thus requires further processing in order to reduce its moisture content to an acceptable range for many of the more popular cheese types in the U.S.A. In making a low moisture cheese from UF retentate there have been two methods used to extract moisture from the cheese curd: Vacuum evaporation for production of a cheese base for process cheese (this product has texture and body unsatisfactory for a value-added 'natural' cheese) and the SIRO-Curd method of using UF retentate to make Cheddar

cheese by passing UF curd through a mechanical syneresis system followed by a mechanical cheddaring system (this is successful in lowering cheese moisture but has suffered from fat losses).

By developing a new UF cheesemaking procedure it will be possible to make low moisture cheeses that retain the high yield of UF. Cheeses in the moisture range of 35-45% are the most widely consumed cheeses in the U.S.A. The introduction of new varieties of cheese would have the greatest opportunity for success if they were in this category. Cheesemaking technology to be developed in this project has the potential to provide opportunities to produce new low moisture cheese products on a cost effective basis.

Is Additional Effort or New Direction Needed Based on Project Findings: No

NDPRB Action:

Publications:

Theses/Dissertations:

Abstracts:

B.J. Orme and D.J. McMahon. 1989. Effect of concentration on coagulation of ultrafiltered milk. 84th American Dairy Science Association Meeting, J. Dairy Sci:Supp. 1, 184.

Patents:

RESEARCH PROJECT
ANNUAL REPORT FORM

Annual Report Date (M/D/Y): May 15, 1990 Project Term (include dates): 9/87-8/89

Dairy Foods Research Center: Western

Dairy Center Director: Dr. J. Kondo

Principal Investigator: Dr. Lynn V. Ogden

Project Title: Continuous Production of Cottage Cheese from Ultrafiltered Skim Milk Retentat

Project Status: Terminated in August, 1989

Project Summary: The use of ultrafiltration as a preconcentration step in the continuous production of cottage cheese curd was explored. Skim milk retentate of 9.1% protein was acidfied at 2°C to pH 4.4-4.8. Strands of cottage cheese curd were formed by quiescently warming acidified retentate to 35°C in teflon tubes. The effect of retentate protein concentration, partial acidfication before ultrafiltration, acidification pH, acid type, cooking time, and cooking temperature on curd firmness, mealiness, degree of matting, and flavor of cottage cheese curd was investigated.

Project Results: Cottage Cheese curd close to commercial curd in firmness, matting, and flavor was produced by quiescently forming curd from 9.1% protein retentate ultrafiltered at the native pH of skim milk. This curd was higher in mealiness than commercial curd samples used as controls. Conditions that minimized mealiness resulted in soft curd. Curd of commercial quality was not achieved.

Significance to the Dairy Industry: Continuous cottage cheese curd formation from retentate could replace the open vats and traditional curd forming and cutting operations. The result could be higher yield, efficiencies in equipment and labor required to form and cut the curd and better sanitation in a closed system.

Is Additional Effort or New Direction Needed Based on Project Findings: A breakthrough is needed to achieve curd of sufficient firmness yet free of mealiness.

NDPRB Action:

RESEARCH PROJECT
ANNUAL REPORT FORM

Annual Report Date (M/D/Y): 6/30/90 Project Term (include dates): 7/1/87-6/30/92

Dairy Foods Research Center: Western

Dairy Center Director: Dr. J.K. Kondo

Principal Investigator: Drs. W.E. Sandine and J.K. Kondo

Project Title: Cloning the nisin and other genes from Lactococcus into Leuconostoc species and amplification of nisin production

Project Status: Active

Project Summary: Leuconostoc organisms are important members of mixed strain lactic starter cultures because they produce carbon dioxide and diacetyl. Leuconostoc organisms do not grow well in milk because of their limited capability to utilize lactose and milk proteins. Therefore, one of the main goals of this project is to introduce the genes for lactose utilization and proteinase activity from lactococci into Leuconostoc. Leuconostoc strains also were shown to over-produce nisin when the nisin genes from Lactococcus were introduced into certain strains of Leuconostoc. Nisin, a "food-grade" preservative, is active against most gram positive spoilage and pathogenic bacteria. Thus, the other main goal is to introduce the nisin genes into Leuconostoc by cloning, and to stabilize production of these genes.

Project Results: Gene transfer techniques (electro-transformation and conjugation) were studies, developed, and optimized. An efficient and rapid technique for conjugal transfer of nisin production and plasmids was developed. Transformation studies indicated that cloned lactococcal genes introduced into Leuconostoc strains are unstable. To solve the instability problems, we are developing a cloning vector based on a characterized, native Leuconostoc plasmid. Also, a novel gene block (PrtA) required for utilization of milk proteins was identified. These genes possibly code for a peptidase/peptide transport system. They are required, in addition to proteinase enzyme genes (PrtM/PrtP), for utilization of milk proteins.

Significance to the Dairy Industry: Leuconostoc species are important starter bacteria for the production of fermented dairy products because of their unique capabilities to produce an appropriate amount of diacetyl and carbon dioxide. Diacetyl is an important flavor component of cultured buttermilk and sour cream and also unripened soft cheese such as cream cheese and cottage cheese. The carbon dioxide produced is important in eye formation in Gouda type cheeses and it also contributes to the effervescent properties of cultured buttermilk. Despite their importance in dairy dairy fermentations, these organisms have limited capabilities to grow in milk. Genetic enhancement of their ability to grow in milk will increase their usefulness in the development of novel fermented dairy products and to expand the production of specialty cheeses now being imported from Europe. Cloning and overproduction of nisin in Leuconostoc has important implications in increasing the safety and shelf-life of perishable fermented dairy products (nisin inhibits Listeria, Clostridium, Staphylococcus, Bacillus, and other gram positive organisms). Development of nisin-producing (and thus nisin resistant) Leuconostoc will also allow for their use with other nisin-producing cultures in mixed and multiple starter systems.

Is Additional Effort or New Direction Needed Based on Project Findings:

NDPRB Action:

RESEARCH PROJECT
ANNUAL REPORT FORM

Annual Report Date (M/D/Y): June 30, 1990 Project Term (include dates): 7/1/87 - 6/31/90

Dairy Foods Research Center: Western

Dairy Center Director: Dr. J.K. Kondo

Principal Investigator: B.L. Geller and W.E. Sandine

Project Title: Characterization of Bacteriophage Receptor Sites of Lactococcus Bacteria

Project Status: Terminates June 30, 1990

Project Summary: The overall objective is to understand the molecular mechanism of phage adsorption by lactococcus bacteria. Specifically the objectives are:

1. To identify the bacterial components including the cell wall and the cell membrane, responsible for phage attachment, release and penetration of phage DNA.
2. To define the phage receptor at the molecular level.
3. To better understand the mechanisms of resistance of binding, release and penetration of phage DNA and use this information in combination with other mechanisms of resistance to ultimately produce permanently altered strains unable to be attacked by bacteriophages.

Project Results: Currently we are studying the mechanism of phage adsorption to L.lactis subsp. lactis C2. First, cells with mutations in binding were isolated and changes in the saccharide components of the cell wall polysaccharides were analyzed by gas chromatography. Lectins with different specificities to the saccharide components of the cell wall polysaccharide were incubated with the cell walls and losses in the abilitites of phage binding to the cell wall were analyzed. Lastly, we used the free saccharide receptor to compete with the cells to bind the phage and thereby inhibited the phage from lysing the cells. The results thus far suggest that the mechanism of phage resistance in most of the mutants of L. lactis subsp. lactis C2 does not involve changes in the carbohydrate receptors. It is possible that some of these mutants have altered membrane proteins which prevent the release and penetration of phage DNA.

Significance to the Dairy Industry: Over 80% of failed fermentation by mesophilic starter cultures are the result of bacteriophage attack. In our last report, we showed that mimic receptors i.e., rhamnose can be used to inhibit infection of phages from L. lactis subsp. cremoris KH. In this report, we demonstrated that rhamnose is also effective in inhibiting or sufficiently delaying infection of phages from L. lactis subsp. lactis C2. Elimination of bacteriophage problems during fermentation means a more efficient cheese production, more uniform products and better consumer acceptance of the products. Without doubt, this translates into better profits to the dairy companies and farmers.

Is Additional Effort or New Direction Needed Based on Project Findings:

NDPRB Action:

RESEARCH PROJECT
ANNUAL REPORT FORM

Annual Report Date (M/D/Y): June 30, 1990 Project Term (include dates): 9/87-12/31/90

Dairy Foods Research Center: Western

Dairy Center Director: Dr. J.K. Kondo

Principal Investigator: Dr. Floyd W. Bodyfelt

Project Title: Production of Omega-3 Fatty Acids by Genetically Altered Fungi and Lactic Acid Bacteria

Project Status: Active

Project Summary:

1. Examine *Saprolegnia parasitica* for extrachromosomal DNA/plasmids with the goal of using an indigenous plasmid for cloning genes facilitating metabolism of lactose.
2. One genetically altered, determine growth and lipid accumulation (fatty acid profile) of *S. parasitica* using lactose as a carbon source.
3. Develop a whey permeate based medium that will provide optimum growth and lipid accumulation by *S. parasitica.*
4. Determine the scale-up economics with an emphasis on optimum lipid extraction from large scale chemostat production into lactic acid bacteria.

Project Results: This research examines an approach to producing PUFAs from fungi genetically altered to lactose utilization. Saprolegnia parasitica, a filamentous fungus, was examined for eicosapentaenoic acid (20:5 omega-3, EPA) production when grown on six media with varied nitrogen and carbon sources. Optimum EPA production reached 24% of total fatty acids. In an effort to produce EPA from lactose, transformation experiments using the plasmid pKRI BLAC4-1 were undertaken. Transformation of protoplasts was by PEG/$CaCl_2$ with 1 to 6 protoplasts/mg DNA transformed. Several stable transformants were obtained. As indicated by Southern hybridization, the plasmid was incorporated genomically. SP829 produced 4-5 units β-galactosidase/mg protein. ^{14}C lactose was used to determine lactose uptake by SP829 mycelia and protoplasts. Radiolabel was not detected in protoplasts or mycelia. This indicates that while β-galactosidase is produced the fungus lacks a functional lactose permease.

Significance to the Dairy Industry: This research has shown that the filamentous fungus *S. parasitica* is capable of producing the omega-3 fatty acid, eicosapentaenoic acid. This end product may have economic significance if a suitable substrate could be found for growing this microorganism. In an attempt to produce EPA from cheese whey permeate, we have genetically altered *S. parasitica.* Subsequently, this organism now produces a functional β-galactosidase. Current research efforts are focusing on cloning a functional lactose permease into the genome of *S. parasitica.* Until this genetic alteration of the organism is accomplished, the goal of utilizing whey permeate as a carbohydrate source to produce omega-3 fatty acids is not likely to be achieved.

Is Additional Effort or New Direction Needed Based on Project Findings: Based on the difficulty in whey permeate disposal, projects that utilize this cheese by-product should be continued. As marine sources of omega-3 fatty acids become diminished, this project may have greater future significance.

NDPRB Action:

RESEARCH PROJECT
ANNUAL REPORT FORM

Annual Report Date (M/D/Y): June 30, 1990 Project Term (include dates): 7/88-6/91

Dairy Foods Research Center: Western

Dairy Center Director: Dr. J.K. Kondo

Principal Investigator: Dr. Mark A. Daeschel

Project Title: Purification of a bacteriocin from *Pediococcus pentosaceus* and genetic transfer of the plasmid borne determinants

Project Status: Active

Project Summary: The primary objectives of this study are twofold.

1. To purify the bacteriocin, Pediocin A, using protein purification methdology to a purity suitable for the production of polyclonal antibodies.
2. To genetically transfer the Pediocin A plasmid (pMD136) into dairy fermentation strains via the current state of the genetic transfer systems that have been demonstrated with lactic acid bacteria.

Project Results: This past year we have concentrated on optimizing electroporation transformation procedures for Pediococci and Lactococci with the view of introducing the Pediocin A plasmid since we are unable at this time to use Pediocin A as a selective agent. Two alternative approaches are being explored. The first approach is to optimize electroporation conditions so that co-transformation of pMD136 and a directly selectable marker (antibiotic resistant plasmid) could occur. Co-transformants could then be individually screened for Pediocin A production. The second approach is to clone into a directly selectable plasmid vector the Pediocin A genes for production and immunity to Pediocin A. both approaches are dependent on high transformation frequencies. We have been able to transform 3 of 5 strains of pediococci using the plasmid vector pNZ12. Transformation frequencies were in the range of 2-3 X 10^2 per ug of DNA. We have also been able to obtain transformation frequencies of about 1 X 10^6 per ug of DNA with lactococcus lactis LM 2302 which will be used as a recipient for pMD 136-pNZ12 co-transformation experiments.

Significance to the Dairy Industry: Of current concern to cheese processors are the occurrence of microorganisms which cause blowing faults (*Clostridia tyrobutyricum*) in Swiss-type cheese and cheeses. Bacteriocin producing starter cultures is one approach for controlling the incidence of such microorganisms in fermented dairy foods. Certain bacteriocins from non-dairy lactic acid bacteria have been shown to inhibit clostridia and Listeria as well as other pathogens such as *Staphylococcus aureus.*

The acquisition of bacteriocin producing ability by dairy starter cultures through genetic biotechnology may allow the development of strains superior to those presently available.

Is Additional Effort or New Direction Needed Based on Project Findings: Efforts will continue to focus on purification of Pediocin A and development of optimal transformation procedures.

NDPRB Action:

RESEARCH PROJECT
ANNUAL REPORT FORM

Annual Report Date (M/D/Y): June 30, 1990 Project Term (include dates): 7/1/88-3/31/91

Dairy Foods Research Center: Western

Dairy Center Director: Dr. J.K. Kondo

Principal Investigator: Mark A. Daeschel and Floyd W. Bodyfelt

Project Title: Prediction and Determination of the Efficacy of Nisin in Dairy Foods

Project Status: Active

Project Summary:

1. To determine what molecular components of milk can interact with nisin and affect its activity.
2. To use the information gained from achieving the first objective to predict and determine the efficacy of nisin as a preservation agent in novel dairy foods such as carbonated milk beverages.
3. To determine the efficacy of nisin on the inhibition of Listeria and psychrotrophic bacilli in selected milk and milk products and the subsequent impact on safety and keeping quality.

Project Results: Beta-lactoglobulin was observed to provide a protective effect to bioassay indicator bacteria when exposed to nisin in the presence of the protein. It is hypothesized that Beta-lactoglobulin may reduce the activity of nisin by binding it and hence preventing it from inhibiting microbial cells. Experiments were conducted to determine the effects that various components of milk have on the efficacy of nisin. Two approaches were used. 1) Determination of nisin activity after exposure of nisin to different types and concentration of dairy proteins and fats. A quantitative bioassay based on well diffusion was employed. 2) Effect of different dairy components on the ability of nisin to inhibit listeria monocytogenes in fluid milk. The most significant effect observed was the reduction in nisin activity as the fat concentration was increased in fluid milk. Nisin activity as determined by bioassay was decreased by more than 90°/0 when added to high fat (11.5%) fluid milk. Concurrently, it was observed that nisin was less effective in inhibiting Listeria as fat concentration increased. A representative experiment is portrayed in the following figure. How milkfat interacts with nisin to reduce its activity is the focus of our current investigations.

Significance to the Dairy Industry: Nisin, after 25 years of safe use in many European countries was recently affirmed by the Food and Drug Administration (Federal Register, April 6, 1988) as GRAS for use as an antimicrobial agent to inhibit the growth of Clostridium botulinum spores and toxin formation in certain pasteurized cheese spreads. The approval of nisin will justify increased research efforts of both an applied and basic nature on the antimicrobial properties of bacteriocins. The use of nisin as an antimicrobial agent in dairy foods could enhance milk utilization by at least three mechanisms:

1. Inhibition of spoilage microorganisms in dairy foods could minimize economic losses due to spoilage.

2. Inhibition of pathogenic and toxigenic bacteria to provide consistently safe products. Contaminated products (such as with Listeria) can give rise to adverse publicity with subsequent sales loss.
3. Extension of the shelf-life of perishable dairy products.

Is Additional Effort or New Direction Needed Based on Project Findings:

NDPRB Action:

Publications:

Theses/Dissertations:

Abstracts:

Daeschel, M.A., D.S. Jung and F.W. Bodyfelt. 1990. Influence of fat on the efficacy of nisin in inhibiting Listera Monocytogenes in fluid milk. Abstract in J. Dairy Sci. 73(6):Suppl. 1.

Patents: None

RESEARCH PROJECT
ANNUAL REPORT FORM

Annual Report Date (M/D/Y): June 30, 1990 Project Term (include dates): 7/1/89 - 6/30/91

Dairy Foods Research Center: Western

Dairy Center Director: Dr. J.K. Kondo

Principal Investigator: Dr. D.J. McMahon

Project Title: Function of whey proteins and lactose in age gelation of ultra-high temperature sterilized milk concentrate

Project Status: Active

Project Summary: The mechanism by which age gelation in UHT sterilized milk concentrates occurs is still unknown. There have been many factors implicated but an empirical approach is taken to extend shelf life of sterilized milk. UHT sterilization promotes association between κ-casein and β-lactoglobulin. In milk concentrates the concentration of whey proteins and lactose are increased. Their role in the age gelation process will be studied in this project. The specific objectives of this project are to:

1. Determine the fate of β-lactoglobulin during storage of UHT sterilized milk concentrates.
2. Determine the influence of lactose concentration of milk concentrates on age gelation.
3. Monitor changes in casein micelle structure during storage of UHT sterilized milk concentrates.

Project Results:

Objective 1: β-lactoglobulin.
The use of ^{14}C-labelled β-lactoglobulin in UHT milk experiments has required that a laboratory scale UHT system be developed so that contaminated equipment can be properly handled.Preliminary trials have been conducted to determine that an equivalent amount of protein denaturation occurs in the two systems. After heat treatment the samples are filled into sterile containers in a cabinet with a positive flow of filtered air to prevent bacterial contamination.

Objective 2: Lactose
Adjustment of Lactose Levels in Milk Preliminary trials have been conducted to determine the best procedure for removing lactose from milk followed by addition of lactose and sucrose at specified levels. Ultrafiltration followed by repeated diafiltration was used to remove most of the lactose from milk. After three diafiltration steps, lactose was reduced from 5.1% to 0.032%. Trials were conducted to determine the optimum way to obtain the proper salt balance in milk during diafiltration.
Measurement of Lactose–Protein Interactions In order to follow the extent of lactose–protein interactions that occur because of Maillard browning reactions it is necessary to have a method to measure the available lysine present on the proteins of UHT milk. An RP-HPLC procedure using a C-18, 250 x 4.6 mm column was developed and proved successful.

Objective 3: Casein Micelle Structure
The microstructure of UHT milk concentrates was investigated using electron microscopy in conjunction with Dr. Miloslav Kalab, Food Research Centre,Ottawa, Canada. It was observed that when 3X skim milk concentrate is heated to 140°C for 4 s, about 60% of the whey proteins are denatured and the casein micelles undergo a large increase in size. This size increase is due to complexing of κ-casein with denatured β-lactoglobulin followed by further aggregation of denatured β-lactoglobulin onto the micelle surface. When such UHT samples are stored and eventually age gel, it was observed that many of the micelles were connected by thin threads of material. The microstructure of such gels was completely different to rennet milk gels.

Significance to the Dairy Industry: International markets for U.S. dairy products could be developed if attention was directed to manufacture of stable products from our surplus dairy production. Specifically, for this project, a way of producing a rehydratable milk concentrate which will not gel before reaching the intended consumers is to be developed. This would make US dairy products more widely available on the world market.

Is Additional Effort or New Direction Needed Based on Project Findings:

NDPRB Action:

PROJECT SUMMARY

Annual Report Date (include year): June 30, 1990

Dairy Food Research Center (identify site): Western Dairy Foods Research Center

Dairy Center Director: Jeffery K. Kondo

Principal Investigator	Project Title	Starting Date	Ending Date	Total Funding	Total NDB Funding* Project	Status
Torres, J. Antonio	Acid Whey Utilization: Func-Properties of a Food Grade Stabilizer Produced by Lactobacillus Plantarum from Acid Whey	07/01/89	06/30/91	43,377	30,653	Active
Hansen, Conly L.	Cogeneration of Biogas and Single Cell Protein From Ultrafiltration Permeate and Whey	07/01/87	06/30/89	59,178	19,724	Completed
Kondo, Jeffery K. and (Sandine, W.E.)	Cloning the Nisin and Other Genes of Lactic Streptococci into Leuconostoc Species and Amplification of Nisin Production	07/01/87 (07/01/87)	06/30/92 (06/30/92)	177,332 (230,323)	132,999 (172,742)	Active
Mahoney, Arthur W.	Iron Fortification of Cheese Curd	08/01/87	06/30/90	42,697	28,466	Completed
Richardson, Gary H.	Acquisition of Zymark II Robot for Laboratory Automation Studies Improving Yield and Physical Properties of Mozzarella Cheese	07/01/87	06/30/90	5,000	3,333	Completed

Principal Investigator	Project Title	Starting Date	Ending Date	Total Funding	Total NDB Funding* Project	Status
Richardson, Gary H.	Improving Yield and Physical Properties of Mozzarella Cheese	07/01/87	06/30/91	67,860	45,609	Active
Ogden, Lynn V.	Continuous Production of Cottage Cheese From Ultra-filtered skim milk Retentate	09/01/87	08/31/89	8,200	5,467	Completed
Cornforth, Daren P.	Evaluation of Milk Proteins as Whitening Agents in Processed Meats and Poultry Products	07/01/87	06/30/90	31,839	21,227	Completed
Olsen, Robert L.	Interaction of Protein and Polysaccharides in Chymosin and Acid Coagulation of Milk	07/01/87	06/30/89	43,160	28,774	Completed
Richardson, Gary H.	Improved Control of Cheese Manufacture through Vat Monitoring	07/01/87	06/30/91	63,300	42,240	Active
Kondo, Jeffery K.	Western Dairy Foods Research Center Administrative Account	07/01/87	06/30/92			Active
Ernstrom, C. Anthon	Effect of Milk Clotting Enzymes on the Curing and Quality of Cheddar Cheese	07/01/87	06/30/88	37,660	25,085	Completed
Sandine, W.E.	Characterization of Bacterio-phage Receptor Sites of Lactic Streptococci	07/01/87	06/30/90	55,256	36,712	Completed

FROM THE DIRECTOR

The 1989-1990 fiscal year (July 1, 1989 to June 30, 1990) was a very active one for the Western Dairy Foods Research Center (WDFRC). This year marked the third year of WDFRC operation and activities. Two projects were completed during this year while six projects scheduled to be completed were granted no-cost extensions based upon the justification(s) stated by the principal investigator supervising the project. Two new projects were approved for the next fiscal year. During fiscal year 1990 the WDFRC administered 23 research projects.

The WDFRC continues to conduct dairy process/product research in four program areas:

- curd formation/cheese technology
- product quality
- microbiology of starter cultures
- ultrafiltration/reverse osmosis membrane technology.

Eighteen principal investigators of the three universities of the WDFRC (Utah State University, Oregon State University, and Brigham Young University) oversee the $572,500 research budget. However, these investigators have been very resourceful in obtaining additional dairy research funds from extramural agencies. All these funds are most important to continue the excellent research being conducted and to further enhance the future goals of the WDFRC.

The WDFRC Annual Meeting was held at Oregon State University during July 12-13, 1990. All the principal investigators and graduate students involved in the research projects were present to give oral progress reports. Poster sessions of some research projects were also set up this year. These posters permitted more interaction among the participants and provided a different format of research results.

The WDFRC Operational Advisory Committee (OAC) met in formal session during the Annual Meeting. OAC members were very open in all their comments about the WDFRC. The OAC expressed enthusiasm about the progress of the WDFRC. Concern was expressed, however, about the need for more communication from the WDFRC to the supporting members of the Center. These constructive comments were noted fully by the administrators of the WDFRC who are actively working to make efficient communication channels from the WDFRC to its contributors as well as to other institutions and organizations in the dairy industry.

The OAC was informed that the National Dairy Promotion and Research Board (NDPRB) would be reviewing the WDFRC during August, 1990. The procedures and protocols of that review were presented to the OAC by Dr. Janet Williams, Director of Research of the NDPRB.

Dr. Paul Savello of Utah State University has assumed the Directorship of the WDFRC. Dr. Savello trusts that his experiences both in private industry dairy research and now in university research prove valuable tools for his administering the vital and exciting research program at the WDFRC. The administration plans to "keep the industry posted" of the WDFRC's activities and to get "feed-back" about our good works as well as those concerns that the WDFRC must review for improvement.

Our goal is common - to increase the utilization of milk and milk products. Working together in such research centers as the WDFRC, this goal can be attained so that we all can feel satisfied that our individual contributions are important to the industry.

Paul A. Savello, Ph.D.
Director

Principal Investigator	Project Title	Starting Date	Ending Date	Total Funding	Total NDB Funding* Project	Status
Bodyfelt, Floyd W.	Rapid Assay for Heat Resistant Microbial Proteases in Raw Milk by a Simple Casein Denaturation Method	08/01/87	12/31/90	36,580	24,439	Active
Bodyfelt, Floyd W.	Production of Omega-3 Fatty Acids by Genetically Altered Fungi and Lactic Acid Bacteria	09/01/87	12/31/90	54,655	36,269	Active
McGuire, Joseph	Characterization of the Post-Absorbtive Behavior of β-Lactoglobulin for Control of Spore and Microbial Adhesion	01/01/88	12/31/90	76,596	51,143	Active
Sandine, W.E.	Studies on the Growth and Survival of Bifidobacterium Species in Milk	07/01/87	06/30/89	36,683	24,455	Completed
Ogden, Lynn V.	Continuous Production of Cottage Cheese From Ultrafiltered Skim Milk Retentate	09/01/87	08/31/89	8,200	5,467	Completed
Ogden, Lynn V.	Method for Identifying Batch or Origin of Semi-continuous Cheese Processes	07/01/88	06/30/90	12,200	0	Completed
Brown, Rodney J.	Application of Fourier Transform Infrared Technology to Milk and Dairy Products	07/01/88	04/30/91	124,921	59,758	Active

Principal Investigator	Project Title	Starting Date	Ending Date	Total Funding	Total NDB Funding* Project	Status
Brown, Rodney J.	Estimation of Individual Milk Proteins and Genetic Variants by Multicomponent Analysis of Amino Acid Profiles	07/01/88	06/30/91	247,893	185,919	Active
Savello, Paul A.	Use of Ultrafiltration and Different Heat Treatments on Yogurt Flavor and Physical Properties	08/01/88	06/30/91	58,200	38,901	Active
Daeschel, Mark A.	Purification of a Bacteriocin From Pediococcus Pentosaceus and Genetic Transfer of the Plasmid Borne Determinant	07/01/88	06/30/91	54,462	40,846	Active
Torres, J. Antonio	Cheddar Cheese Blocks: Effect of Cheese Composition and Cooling Method	07/01/88	12/31/90	42,742	22,055	Active
Hansen, Conly L. and (Torres, J.A.)	Comparison Between 40 and 640 lb Blocks of Uniform Cooling of 640 lb Blocks	11/01/88 (11/01/88)	12/31/91 (12/31/91)	17,900 (32,344)	12,386 (22,381)	Active
McMahon, Donald J.	Variations in Casein Composition of Milk High Yield, Low Moisture Cheese From Homogenized Milk	09/01/88	08/31/91	79,356	63,629	Active
Mahoney, Arthur W.	Evaluation of Iron-Protein Complexes in Iron-Fortified Dairy Products	10/04/88	06/30/91	82,037	66,495	Active

Principal Investigator	Project Title	Starting Date	Ending Date	Total Funding	Total NDB Funding* Project	Status
Hansen, Conly L.	A New Method for Measuring Syneresis of Renneted Gels Applied to Development of Cheese	03/01/89	03/01/91	23,912	15,941	Active
McDaniel, Mina R.	Optimization of the Sensory Qualities of Flavored Yogurt	07/01/88	06/30/90	32,127	21,364	Completed
Daeschel, Mark A.	Prediction and Determination of the Efficacy of Nisin in Dairy Foods	07/01/88	03/31/91	39,407	26,131	Active
McMahon, Donald J.	Function of Whey Proteins and Lactose in Age Gelation of Ultra-High Temperature Sterilized Milk Concentrate	07/01/89	06/30/91	50,000	33,000	Active

* Please underline dollars if amounts differ from **total** originally proposed.

6. Technology transfer -- elaborate on events/opportunities which have provided for the transfer or dissemination of technologies developed through Center-funded research:

Use of rhamnose and rhamnose containing materials to inhibit bacteriophages of lactic acid and related bacteria. A disclosure document has been filed with the Oregon State University Technology Transfer Office. It is being evaluated by patent attorneys.

7. Publications (attach any publications or abstracts for Center-funded research):

Lynn V. Ogden

Lord, E.D. 1990. Ultrafiltration and Direct Acidification in the Manufacture of Cottage Cheese. Masters Thesis. Department of Food Science and Nutrition, Brigham Young University. Manuscript ready for submission to Journal of Dairy Science.

Dunn, M.L. 1989. Method of Identifying the Batch of Origin in Semi-Continuous Cheesemaking Processes. Masters Thesis. Department of Food Science and Nutrition, Brigham Young University. Manuscript ready for submission to Journal of Dairy Science.

Joseph McGuire

McGuire, J. and S.A. Kirtley. Surface characterization for prediction of food particle behavior at interfaces: theoretical considerations and limitations. *Journal of Food Engineering. 8:* 273-286. 1988.

McGuire, J. A predictive model for food particle interactions with contact surfaces. *Journal of Food Science. 54:* 22-24,29. 1989.

McGuire, J. and S.A. Kirtley. On surface characterization of materials targeted for food contact. *Journal of Food Science. 54:* 224-226. 1989.

McGuire, J. Elucidation of the surface influence on irreversible protein adsorption. *Biofouling. 1:* 263-267. 1989.

McGuire, J. and K.R. Swartzel. The influence of solid surface energetics on macromolecular adsorption from milk. *Journal of Food Processing and Preservation. 13:* 145-160. 1989.

Kirtley, S.A. and J. McGuire. On differences in surface constitution of dairy product contact materials. *Journal of Dairy Science.* 72:1748-1753. 1989.

Lee, E. *Temperature Effects on Surface Energetic Parameters Evaluated at Solid-Liquid Interfaces.* M.S. Thesis, Oregon State University. 104 pages. 1989.

Luey, J. *The Effect of pH and ionic Strength on the Adsorption of β-lactoglobulin onto Well-Characterized Silicon.* M.S. Thesis, Oregon State University. 53 pages. 1990.

McGuire, J. Temperature Influences on Food Contact Surface Energetics. In *Engineering and Food,* W.E.L. Spiess and H. Schubert (eds.), Elsevier Applied Science, New York and London. **In press.**

McGuire, J. and R.D. Sproull. Temperature effects on food contact surface properties. *Journal of Food Science.* In press.

McGuire, J. On evaluation of the polar contribution to contact material surface energy. *Journal of Food Engineering.* In press.

Joseph McGuire (continued)

McGuire, J., K. Al-malah, F.W. Bodyfelt and M.J. Gamroth. Application of Eellipsometry to evaluation of cleaning effectiveness. *Journal of Food Science.* **In press.**

McGuire, J., E. Lee and R.D. Sproull. Temperature influences on surface energetic parameters evaluated at solid-liquid interfaces. *Surface and Interface Analysis.* **In press.**

William E. Sandine

Valyasevi, R., Sandine, W.E. and B.L. Geller. The bacteriophage kh receptor of *Lactococcus lactis* subsp. cremoris KH is the rhamnose of the extracellular wall polysaccharide. Appl. Environ. Microbiol. (in press)

Wyckoff, H.A., W.E. Sandine, and J.K. Kondo. 1990. Transformation of dairy Leuconostoc using plasmid vectors from *Bacillus, Eschericia coli,* and *Lactococcus* hosts. Submitted for publication, Appl. Environ. Microbiol.

Floyd W. Bodyfelt

Meer, Ralph R. 1988. Identification and characterization of some psychrotrophic heat resistant/sporeforming bacteria in the Grade A raw milk supply of Oregon. M.S. Thesis. Oregon State University, Corvallis, 81 p.

Meer, R.R. and F.W. Bodyfelt. 1990. Psychrotropic *Bacillus* sp. in fluid milk products: A review. Manuscript in preparation for *J. Food Protection.*

Meer, R.R. and F.W. Bodyfelt. 1990. Identification and characterization of heat resistant psychrotropic *Bacilli* sp. in Oregon Grade A raw milk. Manuscript in preparation for *J. Food Protection.*

J. Antonio Torres

Martino, M., Torres, J.A., Bodyfelt, F.W., and Daeschel, M.A. 1990. Characterization and isolation of a polysaccharide produced by *Lactobacillus plantarum* from acid whey. In preparation.

Martino, M., Daeschel, M.A., and Torres, J.A. 1990. Caracterizacion fisicoquimica de un hidrocoloide obtenido a partir de la fermentacion de suero de leche. In preparation.

Grazier, C., McDaniel, M.R., Bodyfelt, F.S., and Torres, J.A. Temperature of maturation effects on the sensory properties of Cheddar cheese. J. Food Sci. (In review)

J. Antonio Torres (continued)

Grazier, C., Simpson, R., Bodyfelt, F.W., and Torres, J.A. Temperature effects on the microbial activities occurring during cooling and aging of Cheddar cheese. J. Food Sci. (In prepration)

Gary H. Richardson

Weimer, B.C., C.J. Oberg, L.V. Moyes, R.J. Brown, and G.H. Richardson. 1989. Comparison of classical ion exchange amino acid analysis and ophthaldioldehyde to characterize proteolysis by *Lactobacillus bulgaricus*. J. Dairy Sci. 72:2872.

Oberg, C.J., B.C. Weimer, L.V. Moyes, R.J. Brown, and G.H. Richardson. 1990. Proteolytic characterization of *Lactobacillus delbrueckii* ssp. *bulgaricus* strains by amino acid analysis. J. Dairy Sci. (In press).

Oberg, C.J., A. Wang, L.V. Moyes, R.J. Brown, and G.H. Richardson. 1990. Effect of proteolytic acitivity of thermolactic cultures on physical properties of Mozzarella cheese. J. Dairy Sci. (In press).

Oberg, C.J., L.V. Moyes, and G.H. Richardson. 1990. Acid production of *Lactococcus lactis* ssp. *cremoris* in curd made at elevated temperatures. J. Dairy Sci. (submitted for publication).

Oberg, C.J., R. Merrill, L.V. Moyes, R.J. Brown, and G.H. Richardson. 1990. Effect of varied rod:cocci ratios of thermolactic cultures on physical properties of Mozzarella cheese. J. Dairy Sci. (In progress).

R. Merrill, C.J. Oberg, L.V. Moyes, R.J. Brown, and G.H. Richardson. 1990. Effect of *Lactobacillus helveticus* cultures on physical properties of Mozzarella cheese. J. Dairy Sci. (In progress).

Jeffery K. Kondo

Broadbent, J.R., Y.C. Chou, K. Gillies, and J.K. Kondo. 1989. Nisin inhibits several gram-positive mastitis-causing pathogens. J. Dairy Sci. 72:3342-3345.

Broadbent, J.R. and J.K. Kondo. 1990. Genetic construction of nisin-producing *Lactococcus lactis* ssp. *cremoris* and analysis of a rapid method for conjugation. Submitted for publication, Appl. Environ. Microbiol.

Wyckoff H.A., W.E. Sandine, and J.K. Kondo. 1990. Transformation of dairy *Leuconostoc* using plasmid vectors from *Bacillus, Eschericia coli,* and *Lactococcus* hosts. Submitted for publication, Appl. Environ. Microbiol.

Gillies, K. and J.K. Kondo. 1990. Plasmid encoded elements required for proteolysis of milk proteins by *Lactoccus lactis* ssp. *lactis* C20. Manuscript in preparation.

Arthur Mahoney

Zhang, D. and A.W. Mahoney. 1989. Effect of iron fortification on quality of Cheddar cheese. J. Dairy Sci. 72:322.

Zhang, D. and A.W. Mahoney. 1989. Bioavailability of iron-milk-protein complexes and fortified Cheddar cheese. J. Dairy Sci. 72:2845.

Zhang, D. and A.W. Mahoney. 1990. Effect of iron fortification on quality of Cheddar cheese. II. Effects of aging and fluorescent light on pilot scale cheeses. J. Dairy Sci. In press.

Zhang, D. and A.W. Mahoney. 1990. Iron fortification of process Cheddar cheese. Submitted to J. Dairy Sci.

Daren Cornforth

Dobson, B.N. 1990. Effects of milk proteins on color and texture of turkey rolls and various beef products. Ph.D. Dissertation, Utah State University, Logan.

8. Financial reports (attach approved financials).

UTAH STATE UNIVERSITY • LOGAN, UTAH 84322

OFFICE OF INTERNAL AUDITS
UMC 1430
Telephone (801) 750-1084

To National Dairy Promotion
and Research Board
Logan, Utah

QUALIFIED INTERNAL AUDITORS' STATEMENT

We have performed an accounting of the Annual Financial Report by Project, of the Western Dairy Research Center, from July 1, 1987 to June 30, 1990.

Keith Sedgwick, Director
Internal Audits

Utah State University
October 4, 1990

ANNUAL FINANCIAL REPORT BY PROJECT

Western Dairy Research Center

Summary Totals for All Projects

Annual Report Ending: June 30, 1990, Final Project Term: 07/01/87 - 06/30/90

Dairy Center Director: Dr. Jeffery K. Kondo

Project Title: SUMMARY TOTALS FOR ALL WESTERN DAIRY CENTER PROJECTS

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Grand Totals	1655337	1313231	342106	1106903	862739	244164	548434	450492	97942

ANNUAL FINANCIAL REPORT BY PROJECT

Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 07/01/87 - 06/30/92

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: KONDO JEFFERY K

Project Title: WESTERN DAIRY FOODS RESEARCH CENTER ADMINISTRATIVE ACCOUNT

Project Status: Active

USU Project Number: 191

USU Account Number: 547785

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	40000	33932	6068	29817	25294	4523	10183	8638	1545
Fringe	12000	9923	2077	8945	7397	1548	3055	2526	529
Supplies	16600	8787	7813	12374	6550	5824	4226	2237	1989
Equipment	6000	6075	-75	0	0	0	6000	6075	-75
Travel	25000	20142	4858	18636	15014	3621	6364	5128	1237
Publication	400	381	19	298	284	14	102	97	5
TOTALS	100000	79240	20760	70070	54539	15531	29930	24701	5229

ANNUAL FINANCIAL REPORT BY PROJECT

Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 07/01/87 - 06/30/91

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: RICHARDSON GARY H

Project Title: IMPROVING YIELD AND PHYSICAL PROPERTIES OF MOZZARELLA CHEESE

Project Status: Active

USU Project Number: 181

USU Account Number: 547780

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	47868	43380	4488	32172	29155	3017	15696	14224	1472
Fringe	10992	11824	-832	7388	7947	-559	3604	3877	-273
Supplies	9000	5008	3992	6049	3366	2683	2951	1642	1309
Equipment	0	400	-400	0	0	0	0	400	-400
Travel	0	435	-435	0	292	-292	0	143	-143
Publication	0	147	-147	0	99	-99	0	48	-48
TOTALS	67860	61193	6667	45609	40859	4750	22251	20334	1917

ANNUAL FINANCIAL REPORT BY PROJECT

Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 07/01/87 - 06/30/91

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: RICHARDSON GARY H

Project Title: IMPROVED CONTROL OF CHEESE MANUFACTURE THROUGH VAT MONITORING

Project Status: Active

USU Project Number: 187

USU Account Number: 547784

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	36200	16683	19517	27160	12517	14643	9040	4166	4874
Fringe	9100	576	8524	6827	432	6395	2273	144	2129
Supplies	8000	15957	-7957	6002	11972	-5970	1998	3985	-1987
Equipment	7000	500	6500	0	0	0	7000	500	6500
Travel	3000	1800	1200	2251	1350	901	749	449	300
Publication	0	44	-44	0	33	-33	0	11	-11
TOTALS	63300	35560	27740	42240	26305	15935	21060	9256	11804

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Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 07/01/88 - 06/30/90

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: TORRES J ANTONIO

Project Title: CHEDDAR CHEESE BLOCKS: EFFECT OF CHEESE COMPSITION AND COOLING METHOD

Project Status: Active

USU Project Number: 202

USU Account Number: 547834

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	13944	15238	-1294	9538	10424	-885	4406	4815	-409
Fringe	698	2493	-1795	477	1706	-1228	221	788	-567
Supplies	15600	13379	2221	10671	9152	1519	4929	4227	702
Equipment	10500	10180	320	0	0	0	10500	10180	320
Travel	2000	1471	529	1368	1006	362	632	465	167
Publication	0	0	0	0	0	0	0	0	0
TOTALS	42742	42761	-19	22055	22287	-232	20687	20475	213

ANNUAL FINANCIAL REPORT BY PROJECT

Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 11/01/88 - 12/31/91

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: HANSEN CONLY L

Project Title: COMPARISION BETWEEN 40 AND 640 LB BLOCKS OF UNIFORM COOLING OF 640 LB BLOCKS

Project Status: Active USU Project Number: 206 USU Account Number: 547838

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	8700	6523	2177	6326	4743	1583	2374	1780	594
Fringe	0	102	-102	0	74	-74	0	28	-28
Supplies	3000	2834	166	2181	2060	121	819	773	45
Equipment	0	0	0	0	0	0	0	0	0
Travel	1600	765	835	1163	556	607	437	209	228
Publication	0	54	-54	0	39	-39	0	15	-15
TOTALS	13300	10278	3022	9670	7473	2197	3630	2805	825

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Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 11/01/88 - 12/31/91

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: TORRES J ANTONIO

Project Title: COOLING RATE OF CHEDDAR CHEESE: COMPARISON BETWEEN 40 AND 640 LB BLOCKS OF UNIFORM COOLING OF 640 LB BLOCKS

Project Status: Active

USU Project Number: 206

USU Account Number: 547862

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	15442	11192	4250	10232	7416	2816	5210	3776	1434
Fringe	772	2534	-1762	512	1679	-1168	260	855	-595
Supplies	12055	14838	-2783	7988	9832	-1844	4067	5006	-939
Equipment	0	0	0	0	0	0	0	0	0
Travel	1600	1317	283	1060	873	188	540	444	95
Publication	0	211	-211	0	140	-140	0	71	-71
TOTALS	29869	30092	-223	19791	19939	-148	10078	10153	-75

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Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 07/01/89 - 06/30/91

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: TORRES J ANTONIO

Project Title: ACID WHEY UTILIZATION: FUNCTIONAL PROPERTIES OF A FOOD GRADE STABILIZER PRODUCED BY LACTOBACILLUS PLANTARUM FROM ACID WHEY

Project Status: Active USU Project Number: 212 USU Account Number: 547877

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	5520	6269	-749	3698	4200	-501	1822	2069	-247
Fringe	276	2267	-1991	185	1519	-1334	91	748	-657
Supplies	14184	10892	3292	9503	7298	2206	4681	3594	1086
Equipment	0	0	0	0	0	0	0	0	0
Travel	600	58	542	402	39	363	198	19	179
Publication	0	0	0	0	0	0	0	0	0
TOTALS	20580	19486	1094	13789	13056	733	6791	6430	361

ANNUAL FINANCIAL REPORT BY PROJECT

Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 08/01/87 - 06/30/90

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: MAHONEY ARTHUR W

Project Title: IRON FORTICIATION OF CHEESE CURD

Project Status: Active USU Project Number: 182 USU Account Number: 547768

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	25800	35000	-9200	17201	23335	-6134	8599	11666	-3066
Fringe	7917	0	7917	5278	0	5278	2639	0	2639
Supplies	7280	4599	2681	4854	3066	1788	2426	1533	894
Equipment	0	0	0	0	0	0	0	0	0
Travel	1700	2504	-804	1133	1670	-536	567	835	-268
Publication	0	100	-100	0	67	-67	0	33	-33
TOTALS	42697	42203	494	28466	28137	329	14231	14066	165

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Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 07/01/87 - 06/30/90

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: CORNFORTH DAREN P

Project Title: EVALUATION OF MILK PROTEINS AS WHITENING AGENTS IN PROCESSED MEATS AND POULTRY PRODUCTS

Project Status: Closed USU Project Number: 184 USU Account Number: 547782

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	25500	24671	829	17001	16448	553	8499	8223	276
Fringe	0	1004	-1004	0	669	-669	0	335	-335
Supplies	0	5675	-5675	0	3783	-3783	0	1891	-1891
Equipment	0	544	-544	0	0	0	0	544	-544
Travel	0	978	-978	0	652	-652	0	326	-326
Publication	6339	201	6138	4226	134	4092	2113	67	2046
TOTALS	31839	33072	-1233	21227	21686	-459	10612	11386	-774

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Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 08/01/87 - 06/30/90

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: BODYFELT FLOYD W

Project Title: RAPID ASSAY FOR HEAT RESISTANT MICROBIAL PROTEASES IN RAW MILK BY A SIMPLE CASEIN DENATURATION METHOD

Project Status: Active

USU Project Number: 195

USU Account Number: 547811

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	14400	5506	8894	9621	3679	5942	4779	1827	2952
Fringe	720	142	578	481	95	386	239	47	192
Supplies	19460	6786	12674	13001	4534	8468	6459	2252	4207
Equipment	0	0	0	0	0	0	0	0	0
Travel	2000	522	1478	1336	348	988	664	173	491
Publication	0	0	0	0	0	0	0	0	0
TOTALS	36580	12955	23625	24439	8655	15784	12141	4300	7841

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Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 01/01/88 - 12/31/90

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: MCGUIRE JOSEPH

Project Title: CHARACTERIZATION OF THE POST-ABSORBTIVE BEHAVIOR OF B-LACTOGLOBULIN FOR CONTROL OF SPORE AND MICROBIAL ADHESION

Project Status: Active USU Project Number: 197 USU Account Number: 547813

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	27360	29193	-1833	18268	19492	-1224	9092	9701	-609
Fringe	1656	1517	139	1106	1013	93	550	504	46
Supplies	43580	21195	22385	29098	14152	14946	14482	7043	7438
Equipment	0	0	0	0	0	0	0	0	0
Travel	4000	3938	62	2671	2630	41	1329	1309	21
Publication	0	0	0	0	0	0	0	0	0
TOTALS	76596	55844	20752	51143	37287	13856	25453	18557	6896

ANNUAL FINANCIAL REPORT BY PROJECT

Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 07/01/88 - 06/30/90

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: OGDEN LYNN V

Project Title: METHOD FOR IDENTIFYING BATCH OF ORIGIN OF SEMI-CONTINUOUS CHEESE PROCESSES

Project Status: Closed USU Project Number: 199 USU Account Number: 547823

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	6100	6100	0	0	0	0	6100	6100	0
Fringe	0	0	0	0	0	0	0	0	0
Supplies	0	0	0	0	0	0	0	0	0
Equipment	0	0	0	0	0	0	0	0	0
Travel	0	0	0	0	0	0	0	0	0
Publication	0	0	0	0	0	0	0	0	0
TOTALS	6100	6100	0	0	0	0	6100	6100	0

ANNUAL FINANCIAL REPORT BY PROJECT

Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 07/01/88 - 04/30/91

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: BROWN RODNEY J

Project Title: APPLICATION OF FOURIER TRANSFORM INFRARED TECHNOLOGY TO MILK AND DAIRY PRODUCTS

Project Status: Active USU Project Number: 201 USU Account Number: 547825

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	34850	26180	8670	28847	21670	7176	6003	4510	1494
Fringe	10455	8400	2055	8654	6953	1701	1801	1447	354
Supplies	2000	4401	-2401	1655	3643	-1987	345	758	-414
Equipment	50250	41015	9235	0	0	0	50250	41015	9235
Travel	1000	2698	-1698	828	2233	-1405	172	465	-293
Publication	0	0	0	0	0	0	0	0	0
TOTALS	98555	82694	15861	39984	34499	5484	58571	48195	10376

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Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 07/01/88 - 06/30/91

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: BROWN RODNEY J

Project Title: ESTIMATION OF INDIVIDUAL MILK PROTEINS AND GENETIC VARIANTS BY MULTICOMPONENT ANALYSIS OF AMINO ACID PROFILES

Project Status: Active USU Project Number: 267 USU Account Number: 547827

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	38438	0	38438	32003	0	32003	6435	0	6435
Fringe	11531	0	11531	9601	0	9601	1930	0	1930
Supplies	145050	98434	46616	120769	81956	38813	24281	16478	7804
Equipment	0	0	0	0	0	0	0	0	0
Travel	1000	998	2	833	831	2	167	167	0
Publication	0	9	-9	0	7	-7	0	1	-1
TOTALS	196019	99440	96579	163205	82794	80411	32814	16646	16167

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Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 10/04/88 - 06/30/90

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: MAHONEY ARTHUR W

Project Title: EVALUATION OF IRON-PROTEIN COMPLEXES IN IRON-FORTIFIED DAIRY PRODUCTS

Project Status: Active

USU Project Number: 208

USU Account Number: 547841

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	29038	23500	5537	27260	22062	5199	1777	1438	339
Fringe	9413	0	9413	8837	0	8837	576	0	576
Supplies	3445	2211	1234	3234	2076	1159	211	135	76
Equipment	0	0	0	0	0	0	0	0	0
Travel	1700	123	1577	1596	116	1480	104	8	96
Publication	0	305	-305	0	287	-287	0	19	-19
TOTALS	43595	26140	17456	40927	24540	16387	2668	1600	1068

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Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 07/01/88 - 06/30/90

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: MCDANIEL MINA R

Project Title: OPTIMIZATION OF THE SENSORY QUALITIES OF FLAVORED YOGURT

Project Status: Active

USU Project Number: 209

USU Account Number: 547863

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	20092	19668	424	13361	13079	282	6731	6589	142
Fringe	3885	6755	-2870	2584	4492	-1908	1301	2263	-961
Supplies	7050	4467	2583	4688	2971	1718	2362	1496	865
Equipment	0	0	0	0	0	0	0	0	0
Travel	1100	1237	-137	732	823	-91	369	414	-46
Publication	0	0	0	0	0	0	0	0	0
TOTALS	32127	32127	0	21364	21364	0	10763	10763	0

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Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 08/01/88 - 07/31/90

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: SAVELLO PAUL A

Project Title: USE OF ULTRAFILTRATION AND DIFFERENT HEAT TREATMENTS ON YOGURT FLAVOR AND PHYSICAL PROPERTIES

Project Status: Active

USU Project Number: 204

USU Account Number: 547828

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	32960	13632	19328	22030	9112	12919	10930	4520	6409
Fringe	8240	204	8036	5508	136	5372	2732	67	2665
Supplies	17000	4277	12723	11363	2859	8504	5637	1418	4219
Equipment	0	0	0	0	0	0	0	0	0
Travel	0	400	-400	0	267	-267	0	133	-133
Publication	0	71	-71	0	48	-48	0	24	-24
TOTALS	58200	18583	39617	38901	12421	26480	19299	6162	13137

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Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 09/01/88 - 08/31/91

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: MCMAHON DONALD J

Project Title: VARIATIONS IN CASIN COMPOSITION OF MILK HIGH YIELD, LOW MOISTURE CHEESE FROM HOMOGENIZED UF MILK

Project Status: Active USU Project Number: 200 USU Account Number: 547839

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	19680	16400	3280	16332	13610	2722	3348	2790	558
Fringe	3149	438	2712	2613	363	2250	536	74	461
Supplies	26850	5524	21326	22283	4585	17698	4567	940	3628
Equipment	0	0	0	0	0	0	0	0	0
Travel	1800	504	1296	1494	418	1076	306	86	220
Publication	0	281	-281	0	233	-233	0	48	-48
TOTALS	51479	23146	28333	42722	19209	23513	8757	3937	4819

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Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 09/01/87 - 08/31/89

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: OGDEN LYNN V

Project Title: CONTINUOUS PRODUCTION OF COTTAGE CHEESE FROM ULTRAFILTRATED SKIM MILK RETENATE

Project Status: Closed USU Project Number: 183 USU Account Number: 547822

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	6124	6124	0	4083	4083	0	2041	2041	0
Fringe	0	0	0	0	0	0	0	0	0
Supplies	1034	428	606	689	285	404	345	143	202
Equipment	0	0	0	0	0	0	0	0	0
Travel	1042	1042	0	695	695	0	347	347	0
Publication	0	0	0	0	0	0	0	0	0
TOTALS	8200	7594	606	5467	5063	404	2733	2531	202

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Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 07/01/87 - 06/30/92

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: KONDO JEFFERY K

Project Title: CLONING THE NISIN AND OTHER GENES OF LACTIC STREPTOCOCCI INTO LEUCONOSTOC SPECIES AND AMPLIFICATION OF NISIN PRODUCTION

Project Status: Active USU Project Number: 188 USU Account Number: 547767

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	50600	54809	-4209	38050	41215	-3165	12550	13594	-1044
Fringe	16368	8708	7660	12308	6548	5760	4060	2160	1900
Supplies	27697	38135	-10438	20827	28676	-7849	6870	9459	-2589
Equipment	12560	4321	8239	0	0	0	12560	4321	8239
Travel	1000	400	600	752	301	451	248	99	149
Publication	0	252	-252	0	189	-189	0	62	-62
TOTALS	108225	106624	1601	71937	76929	-4992	36288	29695	6593

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Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 07/01/87 - 06/30/92

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: SANDINE W E

Project Title: CLONING THE NISIN AND OTHER GENES OF LACTIC STREPTOCOCCI INTO LEUCONOSTOC SPECIES AND AMPLIFICATION OF NISIN PRODUCTION

Project Status: Active USU Project Number: 188 USU Account Number: 547804

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	73320	63606	9714	50047	43416	6630	23273	20190	3083
Fringe	19986	11597	8389	13642	7916	5726	6344	3681	2663
Supplies	36066	43712	-7646	24618	29837	-5219	11448	13875	-2427
Equipment	3500	3955	-455	0	0	0	3500	3955	-455
Travel	0	2099	-2099	0	1433	-1433	0	666	-666
Publication	0	0	0	0	0	0	0	0	0
TOTALS	132872	124969	7903	88307	82602	5705	44565	42367	2198

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Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 07/01/87 - 06/30/90

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: SANDINE W E

Project Title: CHARACTERIZATION OF BACTERIOPHAGE RECEPTOR SITES OF LACTIC STREPTOCOCCI

Project Status: Active USU Project Number: 194 USU Account Number: 547810

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	22320	27994	-5674	14829	18599	-3769	7491	9395	-1904
Fringe	8936	3223	5713	5937	2142	3796	2999	1082	1917
Supplies	24000	21887	2113	15946	14542	1404	8054	7345	709
Equipment	0	0	0	0	0	0	0	0	0
Travel	0	2169	-2169	0	1441	-1441	0	728	-728
Publication	0	0	0	0	0	0	0	0	0
TOTALS	55256	55272	-16	36712	36723	-11	18544	18549	-5

ANNUAL FINANCIAL REPORT BY PROJECT

Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 09/01/87 - 08/31/91

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: BODYFELT FLOYD W

Project Title: PRODUCTION OF OMEGA-3 FATTY ACIDS BY GENETICALLY ALTERED FUNGI AND LACTIC ACID BACTERIA

Project Status: Active USU Project Number: 196 USU Account Number: 547812

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	14400	18371	-3971	9556	12191	-2635	4844	6180	-1336
Fringe	8705	2856	5849	5777	1895	3881	2928	961	1967
Supplies	29550	24661	4889	19609	16365	3245	9941	8296	1645
Equipment	0	1791	-1791	0	0	0	0	1791	-1791
Travel	2000	1435	565	1327	952	375	673	483	190
Publication	0	0	0	0	0	0	0	0	0
TOTALS	54655	49114	5541	36269	31404	4866	18386	17711	675

ANNUAL FINANCIAL REPORT BY PROJECT

Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 07/01/88 - 06/30/91

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: DAESCHEL MARK A

Project Title: PURIFICATION OF A BACTERIOCIN FROM PEDIOCOCCUS PENTOSACEUS AND GENETIC TRANSFER OF THE PLASMID BORNE DETERMINANT

Project Status: Active USU Project Number: 203 USU Account Number: 547833

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	15492	18159	-2667	10355	12138	-1783	5137	6022	-884
Fringe	775	3310	-2535	518	2212	-1694	257	1097	-841
Supplies	15645	11962	3683	10457	7995	2462	5188	3967	1221
Equipment	0	239	-239	0	0	0	0	239	-239
Travel	2250	257	1993	1504	172	1332	746	85	661
Publication	0	0	0	0	0	0	0	0	0
TOTALS	34162	33927	235	22834	22517	317	11328	11410	-82

ANNUAL FINANCIAL REPORT BY PROJECT

Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 07/01/88 - 06/30/91

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: DAESCHEL MARK A

Project Title: PREDICTION AND DETERMINATION OF THE EFFICACY OF NISIN IN DAIRY FOODS

Project Status: Active

USU Project Number: 207

USU Account Number: 547864

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	13944	12758	1186	9246	8460	787	4698	4298	400
Fringe	6563	4972	1591	4352	3297	1055	2211	1675	536
Supplies	17400	7849	9551	11538	5205	6333	5862	2644	3218
Equipment	0	0	0	0	0	0	0	0	0
Travel	1500	325	1175	995	215	779	505	109	396
Publication	0	0	0	0	0	0	0	0	0
TOTALS	39407	25904	13503	26131	17177	8954	13276	8727	4549

ANNUAL FINANCIAL REPORT BY PROJECT

Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 07/01/89 - 06/30/91

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: MCMAHON DONALD J

Project Title: FUNCTION OF WHEY PROTEINS AND LACTOSE IN AGE GELATION OF ULTRA-HIGH TEMPERATURE STERILIZED MILK CONCENTRATE

Project Status: Active

USU Project Number: 211

USU Account Number: 547867

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	9900	9000	900	6534	5940	594	3366	3060	306
Fringe	2970	2880	90	1960	1901	59	1010	979	31
Supplies	10930	1127	9803	7214	744	6470	3716	383	3333
Equipment	0	0	0	0	0	0	0	0	0
Travel	1200	0	1200	792	0	792	408	0	408
Publication	0	0	0	0	0	0	0	0	0
TOTALS	25000	13007	11993	16500	8584	7916	8500	4422	4078

ANNUAL FINANCIAL REPORT BY PROJECT

Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 03/01/89 - 03/01/91

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: HANSEN CONLY L

Project Title: A NEW METHOD FOR MEASURING SYNERESIS OF RENNETED GELS APPLIED TO DEVELOPMENT OF CHEESE

Project Status: Closed USU Project Number: 210 USU Account Number: 547848

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	3345	3345	0	2192	2192	0	1153	1153	0
Fringe	95	95	0	62	62	0	33	33	0
Supplies	1080	1080	0	708	708	0	372	372	0
Equipment	0	0	0	0	0	0	0	0	0
Travel	962	962	0	630	630	0	331	331	0
Publication	0	0	0	0	0	0	0	0	0
TOTALS	5481	5481	0	3592	3592	0	1889	1889	0

ANNUAL FINANCIAL REPORT BY PROJECT

Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 07/01/87 - 06/30/88

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: ERNSTROM C ANTHON

Project Title: EFFECT OF MILK CLOTTING ENZYMES ON THE CURING AND QUALITY OF CHEDDAR CHEESE

Project Status: Closed USU Project Number: 192 USU Account Number: 547802

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	27837	27837	0	18509	18509	0	9328	9328	0
Fringe	541	541	0	360	360	0	181	181	0
Supplies	0	0	0	0	0	0	0	0	0
Equipment	0	0	0	0	0	0	0	0	0
Travel	600	600	0	399	399	0	201	201	0
Publication	46	46	0	31	31	0	15	15	0
TOTALS	29024	29024	0	19298	19298	0	9726	9726	0

ANNUAL FINANCIAL REPORT BY PROJECT

Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 07/01/87 - 06/30/89

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: HANSEN CONLY L

Project Title: COGENERATION OF BIOGAS AND SINGLE CELL PROTEIN FROM ULTRAFILTRATION PERMEATE AND WHEY

Project Status: Closed USU Project Number: 189 USU Account Number: 547766

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	50774	50774	0	16923	16923	0	33851	33851	0
Fringe	2435	2435	0	812	812	0	1623	1623	0
Supplies	4897	4897	0	1632	1632	0	3265	3265	0
Equipment	0	0	0	0	0	0	0	0	0
Travel	966	966	0	322	322	0	644	644	0
Publication	106	106	0	35	35	0	71	71	0
TOTALS	59178	59178	0	19724	19724	0	39454	39454	0

ANNUAL FINANCIAL REPORT BY PROJECT

Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 07/01/87 - 06/30/89

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: OLSEN ROBERT L

Project Title: INTERACTION OF PROTEIN AND POLYSACCHARIDES IN CHYMOSIN AND ACID COAGULATION OF MILK

Project Status: Closed USU Project Number: 186 USU Account Number: 547783

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	22938	25652	-2714	15627	17476	-1849	7311	8176	-865
Fringe	6862	5714	1148	4675	3893	782	2187	1821	366
Supplies	10556	8538	2018	7192	5817	1375	3364	2721	643
Equipment	900	1352	-452	0	0	0	900	1352	-452
Travel	800	800	0	545	545	0	255	255	0
Publication	0	0	0	0	0	0	0	0	0
TOTALS	42056	42056	0	28039	27731	308	14017	14325	-308

ANNUAL FINANCIAL REPORT BY PROJECT

Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 07/01/87 - 06/30/89

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: SANDINE W E

Project Title: STUDIES ON THE GROWTH AND SURVIVAL OF BIFIDOBACTERIUM SPECIES IN MILK

Project Status: Closed USU Project Number: 198 USU Account Number: 547814

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	14760	17873	-3113	9840	11916	-2075	4920	5957	-1037
Fringe	5923	106	5817	3949	70	3878	1974	35	1939
Supplies	16000	18705	-2705	10667	12471	-1803	5333	6234	-902
Equipment	0	0	0	0	0	0	0	0	0
Travel	0	0	0	0	0	0	0	0	0
Publication	0	0	0	0	0	0	0	0	0
TOTALS	36683	36683	0	24457	24457	0	12226	12226	0

ANNUAL FINANCIAL REPORT BY PROJECT

Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 09/01/87 - 08/31/89

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: ERNSTROM C ANTHON

Project Title: CONTINUOUS PRODUCTION OF COTTAGE CHEESE FROM ULTRA-FILTRATED SKIM MILK RETENATE

Project Status: Closed USU Project Number: 183 USU Account Number: 547781

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	0	1950	-1950	0	1950	-1950	0	0	0
Fringe	0	637	-637	0	637	-637	0	0	0
Supplies	8700	5631	3069	8700	5631	3069	0	0	0
Equipment	0	0	0	0	0	0	0	0	0
Travel	0	435	-435	0	435	-435	0	0	0
Publication	0	47	-47	0	47	-47	0	0	0
TOTALS	8700	8700	0	8700	8700	0	0	0	0

ANNUAL FINANCIAL REPORT BY PROJECT

Western Dairy Research Center

Annual Report Ending: June 30, 1990, Final

Project Term: 07/01/87 - 06/30/90

Dairy Center Director: Dr. Jeffery K. Kondo

Principal Investigator: RICHARDSON GARY H

Project Title: ACQUISITION OF ZYMARK II ROBOT FOR LABORATORY AUTOMATION STUDIES

Project Status: Active USU Project Number: 190 USU Account Number: 547769

Budget Summary	Total Funds			NDPRB Funds			Local Funds		
	Allocated	Spent	Balance	Allocated	Spent	Balance	Allocated	Spent	Balance
Salaries/ Wages	1474	1474	0	983	983	0	491	491	0
Fringe	0	0	0	0	0	0	0	0	0
Supplies	1455	1236	219	970	824	146	485	412	73
Equipment	0	0	0	0	0	0	0	0	0
Travel	1963	1963	0	1309	1309	0	654	654	0
Publication	108	108	0	72	72	0	36	36	0
TOTALS	5000	4781	219	3334	3188	146	1667	1594	73

Western Dairy Foods Research Center
1990 Annual Meeting Agenda
LaSells Stewart Center, Oregon State University

Thursday, July 12, 1990, Agricultural Science Room

9:00 Opening remarks and introductions: Jeffery K. Kondo, Floyd Bodyfelt.

Welcome and comments: Dr. Roy Arnold, Dean, College of Agriculture and Science, Oregon State University.

9:30-10:45 Oral progress reports

Curd formation/cheese technology

9:30 Cooling rate of Cheddar cheese: comparison between 40 and 640 lb blocks and uniform cooling of 640 lb blocks. Dr. Conly L. Hansen and Sterling Larsen, Utah State University; Dr. J. Antonio Torres, Oregon State University.

10:00 Cheddar cheese blocks: effect of cheese composition and cooling method. Dr. J. Antonio Torres, Connie Grazier, Ricardo Simpson, and Jorge Bouzas, Oregon State University.

10:15 Improving yield and physical properties of mozzarella cheese. Dr. Gary H. Richardson and Dr. Craig J. Oberg, Utah State University.

10:30 Improved control of cheese manufacture through vat monitoring. Dr. Gary H. Richardson and Mike LeFevre, Utah State University.

10:45-11:00 Break; Investigators: please set up posters.

11:00-12:00 Poster session, First Interstate Bank Room

12:00-1:00 Lunch, Autumn Room, McNary Dining Hall

1:00-2:00 Continue Poster session, First Interstate Bank Room

Microbiology of starter cultures

Oral presentations (Agricultural Science Room):

2:00 Production of omega-3 fatty acids by genetically altered fungi and lactic acid bacteria. Floyd Bodyfelt and Sam Beattie, Oregon State University.

2:15 Characterization of bacteriophage receptor sites of lactic streptococci. Dr. William E. Sandine, Dr. Bruce Geller, and Rudy Valysevi, Oregon State University.

2:30 Use of 16S ribosomal RNA probes for identification of Lactococcus lactis ssp. cremoris. Dr. William E. Sandine, Dr. S. J. Giovannoni, and May-Soon Salama, Oregon State University.

2:45 Cloning the nisin and other genes of lactic streptococci into Leuconostoc species and amplification of nisin production. Dr. W. E. Sandine and Herb Wyckoff, Oregon State University; Dr. Jeffery K. Kondo and Jeffery R. Broadbent, Utah State University.

3:15 Break

Product Quality

Oral presentations:

3:30 Application of fourier transform infrared technology to milk and dairy products. Dr. Rodney J. Brown and Ivan Mendenhall, Utah State University.

3:45 Estimation of individual milk proteins and genetic variants by multicomponent analysis of amino acid profiles. Dr. Rodney J. Brown and Carol Hollar, Utah State University.

4:00 Adjourn for the day.

5:00-7:00 Salmon BBQ-Indian Style, Maple Grove-Avery Park

7:00-9:30 p.m. Operational Advisory Committee meeting, Agricultural Science Room, LaSells Stewart Center

Friday, July 13, 1990

Oral presentations:

9:00 a.m. Iron fortification of cheese curd. Dr. Arthur Mahoney, Dr. Dejia Zhang, and Dr. Mohan Reddy, Utah State University.

9:15 Method for identifying batch of origin of semi-continuous cheese processes. Dr. Lynn V. Ogden, Brigham Young University.

9:30 Optimization of the sensory qualities of flavored yogurt. Dr. Mina R. McDaniel and Debbie Barnes, Oregon State University.

9:45 New projects approved for funding (approximately 5-10 min each):

Development of a process for production of UF milk retentate powder. Dr. Conly L. Hansen and Dr. Donald J. McMahon, Utah State University.

Controlling age gelation of UHT sterilized milk concentrates. Dr. Donald J. McMahon, Utah State University.

Membrane fractionation of immunoglobulins from milk and whey. Dr. Paul A. Savello, Utah State University.

Characterization of milk proteolysis by lactococcal starter culture strains using amino acid analysis. Dr. Rodney J. Brown and Dr. Jeffery K. Kondo, Utah State University.

Causes and prevention of sticky texture in Mozzarella cheese. Dr. Gary H. Richardson and Dr. Craig Oberg, Utah State University.

Utilization of acid whey as a substrate for the production of food grade cellulases. Dr. Michael Penner, Oregon State University.

Growth of bifidobacteria in milk: association with Streptococcus thermophilus and Lactobacillus species as measured by genetic and enzymatic probes. Dr. William E. Sandine and Dr. Jane Trempy, Oregon State University

10:30 Break

11:00-12:00 Last chance to look at posters

12:00-1:00 Lunch

1:00 Discussion of NDPRB review, August 22-23, 1990.

2:00 Research group discussions

4:00 Adjourn meeting

Poster session:

Product quality.

Rapid assay for heat resistant microbial proteases in raw milk by a simple casein denaturation method. Floyd Bodyfelt and Sergio Feijoo, Oregon State University.

Evaluation of milk proteins as whitening agents in processes meat and poultry products. Dr. Daren P. Cornforth and Brent Dobson, Utah State University.

Characterization of the post-absorptive behavior of B-lactoglobulin for control of spore and microbial adhesion. Dr. Joseph McGuire and Viwat Krisdhasimay, Oregon State University.

Evaluation of iron-protein complexes in iron-fortified dairy products. Dr. Arthur Mahoney and Dr. Mohan Reddy, Utah State University.

Ultrafiltration/Reverse Osmosis

High yield, low moisture cheese from homogenized UF milk. Dr. Don McMahon and Brian Orme, Utah State University.

Use of ultrafiltration and different heat treatments on yogurt flavor and physical properties. Dr. Paul A. Savello and Richard Dargan, Utah State University.

Ultra-high Temperature Processing

Function of whey proteins and lactose in age gelation of ultra-high temperature sterilized milk concentrate. Dr. Don McMahon and Mrudula Kalpalathika, Utah State University.

Microbiology of Starter Cultures

Purification of a bacteriocin from Pediococcus pentosaceus and genetic transfer of the plasmid borne determinant. Dr. Mark A. Daeschel and Xintian Ming, Oregon State University.

Prediction and determination of the efficacy of nisin in dairy foods. Dr. Mark A. Daeschel and Dong-Sun Jung, Oregon State University.

Acid-whey utilization: functional properties of a food grade stabilizer produced by Lactobacillus plantarum from acid whey. Dr. J. Antonio Torres, Dr. Mark A. Daeschel, Miriam Martino, and Nilo Youssef-Hakimi, Oregon State University.

PROJECT SUMMARY

Annual Report Date (include year): June ~~30~~ 01, 1990

Dairy Food Research Center (identify site): Western Dairy Foods Research Center

Dairy Center Director: Jeffery K. Kondo

Principal Investigator	Project Title	Starting Date	Ending Date	Total Funding	Total NDB Funding* Project	Status
Torres, J. Antonio	Acid Whey Utilization: Functional Properties of a Food Grade Stablizer Produced by Lactobacillus Plantarum from Acid Whey	07/01/89	06/31/91 /30/	17,406		Active
Hansen, Conly L.	Cogeneration of Biogas and Single Cell Protein From Ultrafiltration Permeate and Whey	07/01/87	06/30/89	0		Completed
Kondo, Jeffery K.	Cloning the Nisin and Other Genes of Lactic Streptococci into Leuconostoc Species and Amplification of Nisin Production	07/01/87	06/30/92	32,105		Active
Mahoney, Arthur W.	Iron Fortification of Cheese Curd	08/01/87	06/30/90	0		Completed Active
Richardson, Gary H.	Acquisition of Zymark II Robot for Laboratory Automation Studies ~~Improving Yield and Physical Properties of Mozzarella Cheese~~	07/01/87	06/30/90	0		Completed Active

* Please underline dollars if amounts differ from **total** originally proposed.

Principal Investigator	Project Title	Starting Date	Ending Date	Total Funding	Total NDB Funding* Project	Status
Richardson, Gary H.	Improving Yield and Physical Properties of Mozzarella Cheese	07/01/87	91 06/30/90	22,620		~~Completed~~ Active
Ernstrom, C. Anthon	Continuous Production of Cottage Cheese From Ultra-filtered skim milk Retentate	09/01/87	08/31/89	0		Completed
Cornforth, Daren P. ✓ Meats and Poultry Products	Evaluation of Milk Proteins as Whitening Agents in Processed	07/01/87	06/30/90	0		~~Completed~~ Active
Olsen, Robert L.	Interaction of Protein and Polysaccharides in Chymosin and Acid Coagulation of Milk	07/01/87	06/30/89	0		Completed
Richardson, Gary H.	Improved Control of Cheese Manufacture through Vat Monitoring	07/01/87	91 06/30/90	14,000		~~Completed~~ Active
Kondo, Jeffery K.	Western Dairy Foods Research Center Administrative Account	07/01/87	06/30/92	50,000		Active
Ernstrom, C. Anthon	Effect of Milk Clotting Enzymes on the Curing and Quality of Cheddar Cheese	07/01/87	06/30/88	0		Completed
Sandine, W. E.	Cloning of the Nisin and Other Genes of Lactic Streptococci into Leuconostoc Species and Amplification of Nisin Production	07/01/87	06/30/92	45,274		Active

* Please underline dollars if amounts differ from **total** originally proposed.

Principal Investigator	Project Title	Starting Date	Ending Date	Total Funding	Total NDB Funding* Project	Status
Sandine, W.E.	Characterization of Bacteriophage Receptor Sites of Lactic Streptococci	07/01/87	06/30/90	18,573		~~Completed~~ Active
Bodyfelt, Floyd W.	Rapid Assay for Heat Resistant Microbial Proteases in Raw Milk by a Simple Casein Denaturation Method	08/01/87	06/30/90	15,260		~~Completed~~ Active
Bodyfelt, Floyd W.	Production of Omega-3 Fatty Acids by Genetically Altered Fungi and Lactic Acid Bacteria	09/01/87	08/31/91	24,890		Active
McGuire, Joseph	Characterization of the Post-Absorbtive Behavior of B-Lactoglobulin for Control of Spore and Microbial Adhesion	01/01/88	12/31/90	24,643		Active
Sandine W.E.	Studies on the Growth and Survival of Bifidobacterium Species in Milk	07/01/87	06/30/89	0		Completed
Ogden, Lynn V.	Continuous Production of Cottage Cheese From Ultrafiltered Skim Milk Retentate	09/01/87	08/31/89	0		Completed
Ogden, Lynn V.	Method for Identifying Batch of Origin of Semi-continuous Cheese Processes	07/01/88	06/30/90	6,100		~~Completed~~ Active

* Please underline dollars if amounts differ from **total** originally proposed.

Principal Investigator	Project Title	Starting Date	Ending Date	Total Funding	Total NDB Funding* Project	Status
Brown, Rodney J.	Application of Fourier Transform Infrared Technology to Milk and Dairy Products	07/01/88	04/30/91	25,205		Active
Brown, Rodney J.	Estimation of Individual Milk Proteins and Genetic Variants by Multicomponent Analysis of Amino Acid Profiles	07/01/88	06/30/91	50,594		Active
Savello, Paul A.	Use of Ultrafiltration and and Different Heat Treatments on Yogurt Flavor and Physical Properties	08/01/88	07/31/90	29,700		Active
Daeschel, Mark A.	Purification of a Bacteriocin From Pediococcus Pentosaceus and Genetic Transfer of the Plasmid Borne Determinant	07/01/88	06/30/91	18,100		Active
Torres, J. Antonio	Cheddar Cheese Blocks: Effect of Cheese Composition and Cooling Method	07/01/88	06/30/90	16,212		~~Completed~~ Active
Hansen, Conly L.	Comparison Between 40 and 640 lb Blocks of Uniform Cooling of 640 lb Blocks	11/01/88	12/31/91	11,000		Active
McMahon, Donald J.	Variations in Casein Composition of Milk High Yield, Low Moisture Cheese From Homogenized Milk	09/01/88	08/31/~~90~~ 91	26,543		Active

* Please underline dollars if amounts differ from **total** originally proposed.

Principal Investigator	Project Title	Starting Date	Ending Date	Total Funding	Total NDB Funding* Project	Status
Mahoney, Arthur W.	Evaluation of Iron-Protein Complexes in Iron-Fortified Dairy Products	10/04/88	06/30/90	0		~~Completed~~ Active
Hansen, Conly L.	A New Method for Measuring Syneresis of Renneted Gels Applied to Development of Cheese	03/01/89	03/01/91	0		Active
Torres, J. Antonio	Cooling Rate of Cheddar Cheese: Comparison Between 40 and 640 lb Blocks of Uniform Cooling of 640 lb Blocks	11/01/88	12/31/91	18,320		Active
McDaniel, Mina R.	Optimization of the Sensory Qualities of Flavored Yogurt	07/01/88	06/30/90	0		~~Completed~~ Active
Daeschel, Mark A.	Prediction and Determination of the Efficacy of Nisin in Dairy Foods	07/01/88	3/31/91 06/30/90	21,177		~~Completed~~ Active
McMahon, Donald J.	Function of Whey Proteins and Lactose in Age Gelation of Ultra-High Temperature Sterilized Milk Concentrate	07/01/89	06/30/91	25,000		Active

* Please underline dollars if amounts differ from **total** originally proposed.