SARE Grass Dairy Research Project Report

This report summarizes the results of a series of compositional, textural and sensory tests performed on different dairy products made with milk from cows fed with grass. A test was conducted using milk from cows fed using conventional diets and the results compared to the grass-based products. The samples of different dairy products were processed on or around the dates in Table 1.

Table 1. Sampling dates

Sample	Date
Grass Milk	May/2009
Grass Milk	Jul/2009
Conventional Milk	Jul/2009
Grass Milk	Oct/2009
Grass Milk	May/2010
Grass Milk	Aug/2010
Conventional Milk	Aug/2010
Grass Milk	Oct/2010
Grass Milk	Dec/2010

The following products were processed at the Babcock Dairy Plant (Unversity of Wisconsin-Madison) and tested using official methods of analysis:

1. Fluid milk [homogenized (except for the first batch of products and pasteurized]
2. Butter
3. Heavy Cream
4. Yogurt
5. Buttermilk

Composition and Microbiological Data

The chemical composition and microbial counts of the milk, cream yogurt and butter samples are summarized in Tables 2-5.

Table 2. Milk Compositional and Microbial counts Results

	Grass Milk May 09	Grass Milk Jul 09	Conv Milk Jul 09	Grass Milk Oct 09	Grass Milk May 2010	Conv Milk Aug 2010	Grass Milk Aug 2010	Grass Milk Oct 2010	Grass Milk Dec 2010
Fat (%)	2.68 *	3.60	4.26	3.06	3.09	3.06	3.07	3.05	2.81
Protein (%)	3.07	3.06	2.99	3.09	3.14	2.70	2.79	3.31	3.72
Ash (%)	0.67	0.68	0.67	0.63	0.69	0.63	0.64	0.69	0.72
Total Solids (%)	10.27	11.85	12.48	11.01	11.30	10.69	10.83	11.41	11.59
Moisture (%)	89.73	88.15	87.52	88.99	88.70	89.31	89.17	88.59	88.41
Standard Plate Count (cfu/mL)	ND	8	1	3	39	41	53	5	56
Coliforms (cfu/mL)	ND	<1	<1	<1	<1	<1	<1	<1	<1

Note that no major compositional differences were found between the grass-based and the conventional milk samples. The low fat content in the grass sample (May 09) can be explained by incorrect sampling since this sample was not homogenized and a fat plug was clearly visible at the top of the bottle.

Table 3. Heavy Cream Compositional and Microbial counts Results

	Grass Cream May 09	Grass Cream July 09	Conv Cream July 09	Grass Cream October 09
Fat (%)	26.97	27.17	26.13	30.19
Protein (%)	2.10	-	-	1.83
Ash (%)	0.44	-	-	0.31
Total Solids (%)	32.51	-	-	31.37
Moisture (%)	67.49	-	-	68.63
Standard Plate Count (cfu/mL)	20	-	-	27
Coliforms (cfu/mL)	<1	-	-	<1

Table 4. Yogurt Compositional and Microbial counts Results

	Grass Yogurt May 09	Grass Yogurt July 09	Conventional Yogurt 09	Grass Yogurt October 09
Fat (%)	2.99	4.22	3.58	2.83
Protein (%)	3.16	2.99	3.06	2.83
Ash (%)	0.68	0.67	0.68	0.66
Total Solids (%)	9.98	12.24	11.53	10.46
Moisture (%)	90.02	87.76	88.47	89.54
Standard Plate Count (cfu/mL)	10	<1	250	670
Coliforms (cfu/mL)	<1	<1	20	<1
Lactic Acid Bacteria (cfu/mL)	$7.4x10^8$	$9.0x10^8$	$6.3x10^8$	$7.6x10^8$

Table 5. Butter Samples Composition

	Grass Butter May 09	Grass Butter July 09	Conv Butter July 09	Grass Butter Oct 09	Grass Butter May 10	Conv Butter Aug 10	Grass Butter Aug 10	Grass Butter Oct 10	Grass Butter Dic 10
Fat (%)	85.51	87.09	87.83	85.36	79.86	86.14	86.88	85.75	81.49
Protein (%)	0.52	0.45	0.40	0.46	0.58	0.20	0.19	0.67	1.16
Ash (%)	0.09	0.08	0.09	0.09	-	-	-	-	-
Moisture (%)	13.27	12.67	11.92	12.94	19.56	13.56	12.83	13.53	17.30

The fatty acid composition of the milk fat was determined by gas chromatography and is summarized in Table 6.

Table 6. Fatty acid profile of the samples

Fatty Acid	Grass Butter May 09	Grass Butter July 09	Conv Butter July 09	Grass Butter Oct 10	Grass Butter May 10	Conv Butter Aug 10	Grass Butter Aug 10	Grass Butter Oct 10	Grass Butter Dec 10
Butyric (C4:0)	3.3	5.2	4.9	4.5	5.3	4.8	5.2	5.1	4.6
Caproic (C6:0)	2.1	2.8	2.7	2.6	3.1	2.7	2.7	2.6	2.6
Caprylic (C8:0)	1.2	1.4	1.4	1.3	1.6	1.3	1.3	1.3	1.3
Capric (C10:0)	2.9	3.0	3.0	2.8	3.6	2.9	2.7	2.5	2.9
Lauric (C12:0)	3.5	3.3	3.4	3.1	3.8	3.2	2.9	2.9	3.4
Tridecanoic (C13:0)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Myristic (C14:0)	10.9	10.8	11.0	11.0	10.9	10.8	10.0	10.4	11.6
Myristoleic (C14:1)	0.7	0.8	1.0	0.9	0.7	0.9	0.7	0.9	1.1
Pentadecanoic (C15:0)	1.2	1.2	1.2	1.3	1.1	1.2	1.2	1.3	1.4
Palmitic (C16:0)	25.6	26.2	30.2	27.7	25.1	30.6	25.9	26.3	31.8
Palmitoleic (C16:1)	1.1	1.1	1.6	1.4	1.0	1.4	1.1	1.2	1.6
Palmitelaidic (C15:1t)	0.6	0.6	0.3	0.7	0.6	0.3	0.5	0.6	0.5
Margaric (C17:0)	0.8	0.7	0.7	0.8	0.7	0.7	0.7	0.7	0.8
Margaroleic (C17:1)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Stearic (C18:0)	13.5	12.3	9.4	10.9	12.0	10.0	13.5	11.7	9.7
Oleic (C18:1)	20.1	19.7	20.6	19.5	18.5	20.6	20.9	21.7	19.1
Elaidic (C18:1t)	6.2	5.2	3.4	5.3	6.2	3.3	5.2	5.4	2.7
Linoleic (C18:2)	1.7	1.6	2.4	1.6	1.6	2.5	1.7	1.4	1.6
Linoelaidic (C18:2t)	1.2	1.1	0.9	1.1	1.1	0.8	1.2	0.9	0.7
Linolenic (C18:3)	0.8	0.8	0.6	0.8	0.8	0.5	0.7	0.7	0.8
Arachidic (C20:0)	0.2	0.2	0.1	0.2	0.1	0.1	0.2	0.2	0.2
Heneicosanoic (C21:0)	1.3	1.0	0.2	1.4	1.3	0.3	0.8	1.3	0.1

The viscosity of the heavy cream samples made with grass and conventional based milk was measured using a Brookfield Viscometer (See Table 7). The color of the cream and butter samples (L,a,b values) was determined using a Minolta Colorimeter.

Table 7. Viscosity test for the heavy cream samples

	Grass Cream-1	Grass Cream-2	Conventional Cream
Viscosity (cP)	43.73	41.20	38.13
Torque (%)	10.93%	10.30%	9.53%

Table 8. Color of Cream

	Grass Cream-1	Grass Cream-2	Conventional Cream
L	97.62	96.39	96.65
a	0.15	-0.75	0.24
b	2.31	8.74	2.30

Table 8. Color of Butter

	Grass Butter-1	Grass Butter-2	Conventional Butter
L	92.19	93.54	96.97
a	-2.72	-3.41	0.25
b	18.15	21.32	2.38

Texture Analysis

The hardness of the butter samples made with both the grass and conventional milks was measured at two different temperatures (7 and 22 °C) using a Texture analyzer.

Table 9. Hardness at 7°C

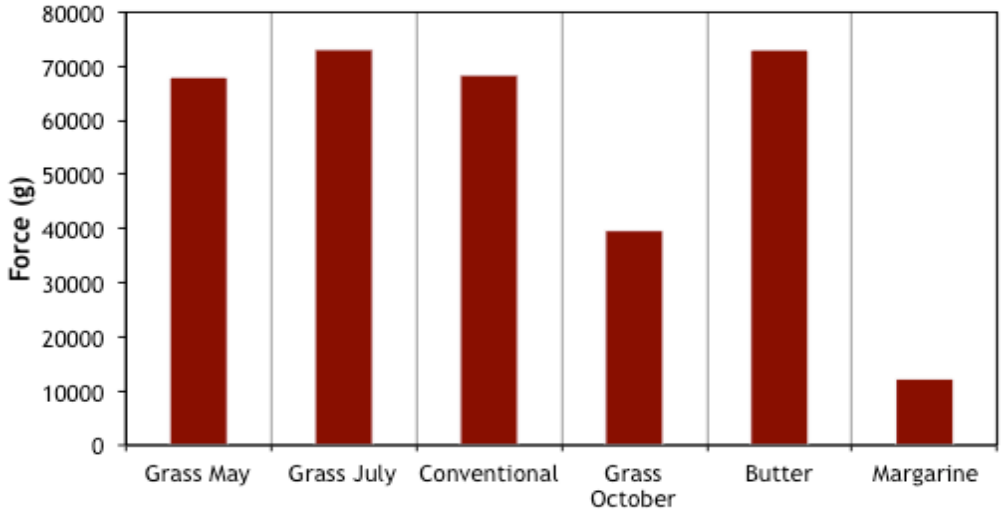
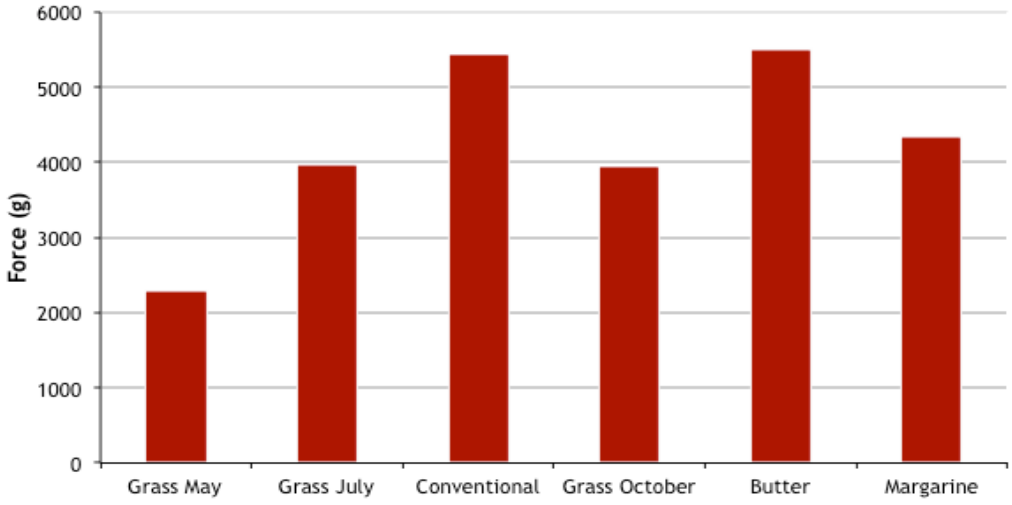


Table 10. Hardness at 22°C



Sensory Analysis

A sensory panel with regular consumers was conducted to compare the flavor attributes of milk and yogurt samples made with the grass-based milk and conventional milk. A total of 100 panelists were recruited and asked to fill a questionnaire about the flavor attributes of the samples. All the tests were conducted at the Sensory Analysis Laboratory of the Department of Food Science at the University of Wisconsin-Madison.

Samples were coded as 183 for the Grass Milk and 601 for the Conventional milk. The following figures and tables summarize the results of this panel.

Figure 3. Intensity of the flavor (Milk)

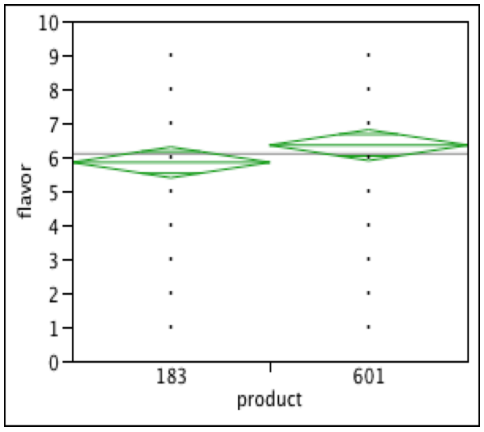


Table 9. Intensity of the flavor (Milk samples) average values

Sample	Mean	Std Error
183	5.840	0.229
601	6.346	0.229

Figure 4. Intensity of the aftertaste (Milk)

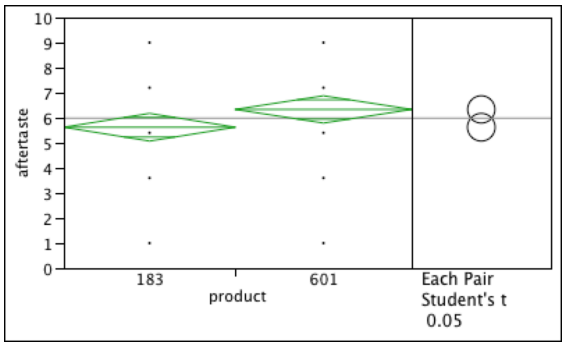


Table 9. Intensity of the aftertaste (Milk samples) average values

Level	Mean	Std Error
183	5.623	0.279
601	6.334	0.275

Panelists were asked if they would buy the products, and their responses are summarized in Figure 5. The scale goes from 0 (not likely) to 10 (very likely to buy)

Figure 5. Willingness to buy the product (183: Grass Milk, 601: Conventional milk)

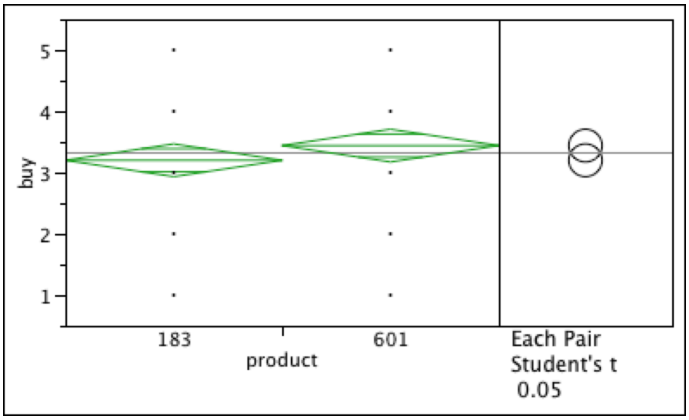
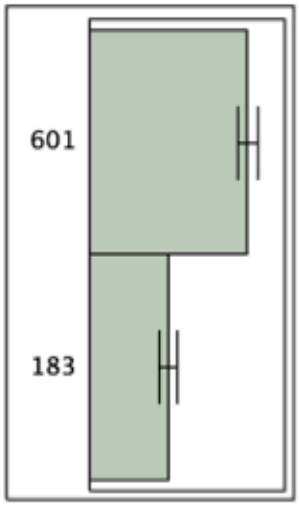


Table 9. Mean values, willingness to buy the product (183: Grass Milk, 601: Conventional milk)

Sample	Mean	Std Error
183	3.20000	0.13506
601	3.44000	0.13506

According to the results of the panel the best overall product (milk) was the conventional milk. However, the results for the intensity of flavor, aftertaste and willingness to buy showed no significant differences between the two products.

Figure 6. Best product overall (Milk)



Sample	Count	Prob
183 (grass)	50	0.33333
601 (conventional)	100	0.66667
Total	150	1.00000

Figure 7. Intensity of the flavor, Yogurt samples

(178: Grass Milk, 407: Conventional milk)

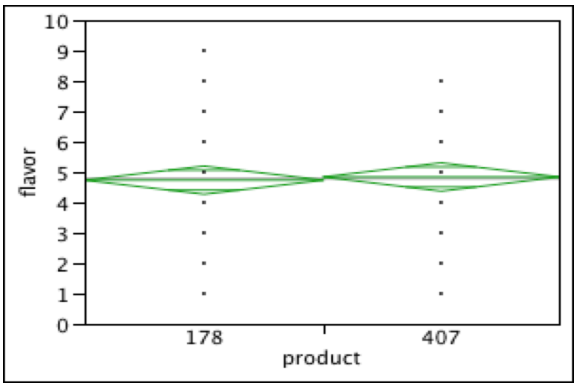


Table 10. Intensity of the flavor (Yogurt samples) average values

Sample	Mean	Std Error
178	4.733	0.234
407	4.837	0.236

Figure 8. Willingness to buy the yogurt (178: Grass Milk, 407: Conventional milk)

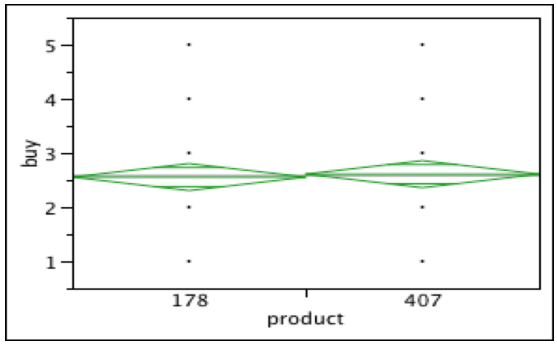
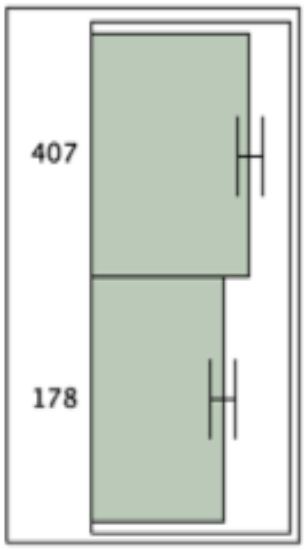


Table 11. Mean values, willingness to buy the yogurt (178: Grass Milk, 407: Conventional milk)

Sample	Mean	Std Error
178	2.554	0.126
407	2.608	0.126

Figure 9. Best product overall (Yogurt)



Level	Count	Prob
178 (grass)	68	0.45333
407 (conventional)	82	0.54667
Total	150	1.00000

Beta-carotene content of the Butter samples

The content of β–carotene in several butter samples was determined by HPLC analysis, the results of this tests are summarized in Table 12

Table 12. β–carotene content of selected butter samples

Sample	β-Carotene (mg/100g)
Grass Butter Oct 2010	0.541
Grass Butter Dec 2010	0.521
Sassy Cow Butter Jul. 2010	0.116
Babcock Hall Butter	0.506
Grassland Butter	0.247

Grass-based Cheese samples (Color)

Cheese Sample	L*	a*	b*
Conventional Gouda	71.46	14.47	37.51
Grass Gouda	78.21	3.53	29.55
Edelweiss Emmentaler	69.70	2.07	26.21
Grass emmentaler	68.27	2.80	30.56