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A2 Milk Research

Results from Different Beta-Casein Proteins

The issue of A2 milk has garnered considerable attention from both consumers and producers in recent years, including National All-Jersey Inc. (NAJ). Three factors served as catalysts for NAJ's interest. First, among the members of National All-Jersey Inc. (NAJ) are producers who are marketing Jersey milk direct to the public. These producers have ample anecdotal evidence from customers that say they have fewer digestive problems with Jersey milk than conventional milk. Second, social media abounds with claims from some consumers that A2 milk does not cause them the digestive stress they experience with conventional milk. Third, one significant difference known to exist between the two milks is that Jersey genetics have a higher frequency of A2 beta-casein than the general dairy cattle population. Therefore, NAJ decided to pursue A2 research with two primary goals:

1. To determine if there is a quantifiable benefit to consumers from A2 and/or Jersey milks.
2. If so, to determine the threshold of A2 at which the benefit can be realized. In other words, does milk need to be 100% A2, or will milks of lesser amounts of A2 also provide benefits.

The research project was led by Dr. Dennis Savaiano and involved clinical trials with persons known to be lactose maldigesters due to problematic digestive symptoms experienced after ingesting lactose. The A2 Milk Company was also interested in this research which led to NAJ and the A2 Milk Company jointly funding the research project, "Comparing the digestion of milk with different beta-casein protein content in lactose maldigesters."

The hypothesis of the research project was that there would be a graded relationship between the content of A2 beta-casein and symptoms of lactose intolerance.

Beginning with 853 people who expressed interest to participate in the study, the prescreening process started with a telephone interview. Eligible subjects were then confirmed to be lactose maldigesters through a hydrogen breath test. Subjects were instructed to consume a low-fiber dinner and fast overnight prior to their visit. On the day of the visit they would consume a dose of high A1 beta-casein milk (commercial milk), containing 0.5g of lactose/kg bodyweight. A rise of 20 parts per million (ppm) hydrogen indicated maldigestion. Subjects were assessed for their Qualifying Lactose Challenge Symptom Score, which measures symptoms like abdominal pain, bloating, flatulence, diarrhea and fecal urgency.

The test subjects that made it through screening underwent a double-blinded, randomized crossover trial with four study visits and a washout period of at least six days between two consecutive visits. Participants received four randomized treatments of milk: (Figure 1)

1. Commercial milk (25% A2)
2. Jersey milk (75% A2)
3. a2 milk (100% A2)
4. Commercial lactose-free milk (control)

Participants would then be monitored for breath hydrogen levels and intolerance symptoms for six hours after consuming a single meal of milk after an overnight fast. Hydrogen in breath samples were measured and self-reported physical symptoms were recorded at 0, 0.5, 1, 1.5, 2, 3, 4, 5 and 6 hours of the study. Only 24 persons completed the clinical trial. Two additional subjects were in the process of

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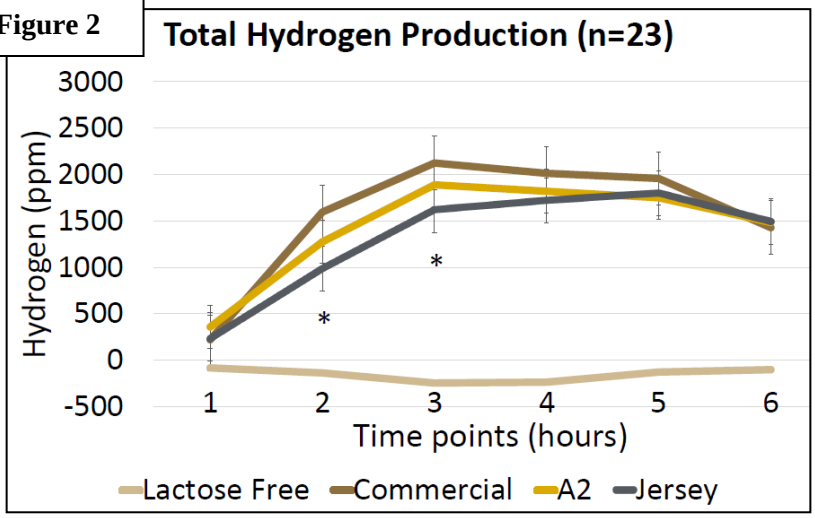
participating when the trial was suspended due to the COVID 19 pandemic.

Figure 1: Nutrient Composition of Milk Treatments

Nutrients	Commercial	Jersey	A2	Lactose-free
Protein (g)	3.3	3.95	3.14	3.21
Fat (g)	1.9	2	2.1	2
Lactose (g)	4.6	4.4	4.7	0.130
CHO (g)	4.6	4.4	4.7	-
Calories (cal)	50	50	54.1	50
A1 (%)	75	25	0	60
A2 (%)	25	75	100	40

Figure 2



Hydrogen Test

Hydrogen production was analyzed in 23 maldigesters. Total hydrogen produced by Jersey milk was significantly lower than A2 and conventional milk (figure 2). A2 milk did not significantly reduce total hydrogen as compared to commercial milk. At each hourly time point (1, 2, 3, 4, 5 and 6 hours), average maldigestion was smaller with Jersey and A2 milk as compared to commercial milk. Jersey milk produced significantly lower hydrogen at 2 and 3 hours compared to commercial milk.

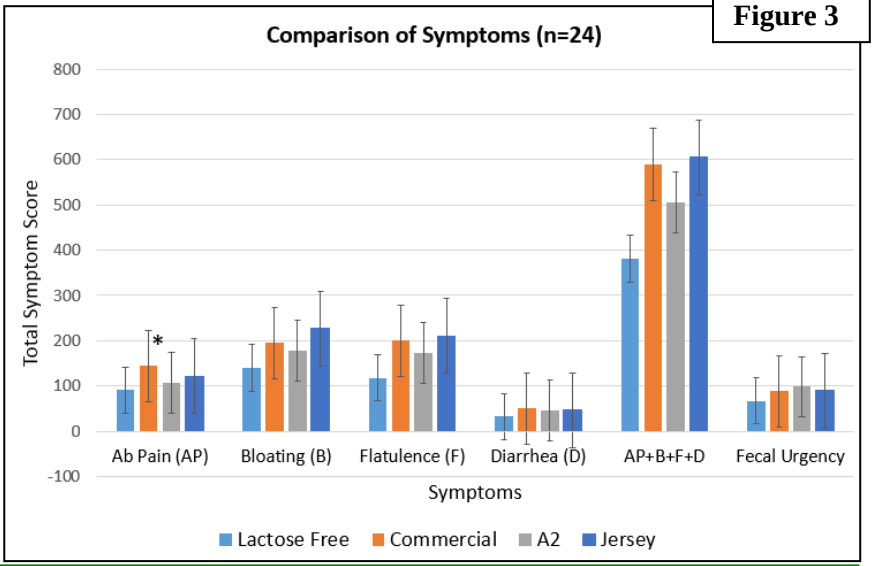
Symptom Comparison

Symptoms for abdominal pain, bloating, flatulence, diarrhea, and fecal urgency were analyzed in 24 verified lactose intolerant subjects. On average for the five symptoms, subjects reported significantly fewer symptoms with A2 milk than they did with commercial milk while Jersey milk was not different from commercial milk (figure 3). When looking at individual symptoms abdominal pain associated with A2 milk was significantly lower, with a score of 108, than commercial milk at 144, Jersey milk also scored lower than commercial milk with a score of 121.

Study Conclusions

Total hydrogen produced by Jersey milk was significantly lower than commercial milk. Total hydrogen produced by A2 was not significantly lower than commercial milk. Total symptoms produced by Jersey milk were not different from commercial milk, while A2 milk was trending towards a reduction in symptoms compared to commercial milk. The results suggest that the sample size should be increased for significance.

Figure 3



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NAJ Milk & Component Outlook - *May 2020 Jersey Price Comparisons*

MAY'20 STATISTICAL BLEND PRICE

Northeast (Boston)	$13.47
Appalachian (Charlotte)	$15.14
Southeast (Atlanta)	$15.39
Florida (Tampa)	$17.29
Mideast (Cleveland)	$12.73
Upper Midwest (Chicago)	$12.31
Central (Kansas City)	$12.24
California (Los Angeles)	$11.95
Southwest (Dallas)	$13.01
Arizona (Phoenix)	$12.38
Pacific Northwest (Seattle)	$11.97
ALL FMMO MARKET AVERAGE	**$13.44**

Prices reflect Federal Order minimum blend prices for city shown.

MAY'20 MONTHLY MILK VOLUME (Million #)

Northeast (Boston)	2,309
Appalachian (Charlotte)	462
Southeast (Atlanta)	386
Florida (Tampa)	201
Mideast (Cleveland)	1,787
Upper Midwest (Chicago)	2,779
Central (Kansas City)	1,394
California (Los Angeles)	1,902
Southwest (Dallas)	925
Arizona (Phoenix)	435
Pacific Northwest (Seattle)	642
ALL FMMO MARKET TOTAL	**13,221**

Total Grade A milk volume sold under FMMO during month.

MAY'20 JERSEY REGULATED BLEND PRICE

Northeast (Boston)	$16.39
Appalachian (Charlotte)	$16.74
Southeast (Atlanta)	$17.18
Florida (Tampa)	$19.09
Mideast (Cleveland)	$14.96
Upper Midwest (Chicago)	$15.11
Central (Kansas City)	$14.94
California (Los Angeles)	$13.14
Southwest (Dallas)	$15.51
Arizona (Phoenix)	$14.16
Pacific Northwest (Seattle)	$14.58
ALL FMMO MARKET AVERAGE	**$15.62**

Prices reflect FMMO minimum prices at Jersey component values.

MAY '20 JERSEY BLEND WITH ESTIMATED PROTEIN OR CHEESE YIELD PREMIUMS

Northeast (Boston)	$16.61
Appalachian (Charlotte) (includes protein prem.)	$17.07
Southeast (Atlanta)	$17.18
Florida (Tampa)	$19.09
Mideast (Cleveland) (includes protein premium)	$15.54
Upper Midwest (Chicago) (includes cy premium)	$15.34
Central (Kansas City)	$14.94
California (Los Angeles)	$13.14
Southwest (Dallas)	$15.51
Arizona (Phoenix) (includes protein)	$14.48
Pacific Northwest (Seattle)	$14.58
ALL FMMO MARKET AVERAGE	**$15.77**

Includes a protein premium of $0.05 for every 0.01% increase in protein over the market average.

MAY'20 DOLLAR DIFFERENCE: JERSEY MILK WITH PREMIUMS VS. STATISTICAL BLEND PRICE

Northeast (Boston)	$3.14
Appalachian (Charlotte)	$1.93
Southeast (Atlanta)	$1.79
Florida (Tampa)	$1.80
Mideast (Cleveland)	$2.81
Upper Midwest (Chicago)	$3.03
Central (Kansas City)	$2.70
California (Los Angeles)	$1.19
Southwest (Dallas)	$2.50
Arizona (Phoenix)	$2.10
Pacific Northwest (Seattle)	$2.61
ALL FMMO MARKET AVERAGE	**$2.33**

Prices reflect difference between Jersey price with premiums, and the statistical blend price.

MAY'20 PERCENT DIFFERENCE: JERSEY MILK WITH PREMIUMS VS. STATISTICAL BLEND PRICE

Northeast (Boston)	23.3%
Appalachian (Charlotte)	12.7%
Southeast (Atlanta)	11.6%
Florida (Tampa)	10.4%
Mideast (Cleveland)	22.1%
Upper Midwest (Chicago)	24.6%
Central (Kansas City)	22.1%
California (Los Angeles)	9.9%
Southwest (Dallas)	19.2%
Arizona (Phoenix)	17.0%
Pacific Northwest (Seattle)	21.8%
ALL FMMO MARKET AVERAGE	**17.7%**

Percent difference in Jersey price with premiums, over the statistical blend price.

ESTIMATED JERSEY MILK COMPOSITION — May-20

Butterfat	4.99
TRUE Protein	3.74
Other Solids	5.73
Solids Not Fat (SNF)	9.47
Cheese Yield (90% Fat Recovery, 38% Moisture)	12.95
CME Block Cheese Price	$ 1.67

REGULATED MILK PRICES — May-20

FMMO Milkfat	$ 1.3756
FMMO True Protein	$ 2.0918
FMMO Other Solids	$ 0.1882

AVERAGE JERSEY PRICE ADJUSTMENT PER CWT: — May-20

FMMO Milkfat Adjustment	$1.58
FMMO True Protein Adjustment	$1.25
FMMO Other Solids Adjustment	($0.01)

NAJ Milk & Component Outlook - *2020 Prices through May*

2020 AVERAGE STATISTICAL BLEND PRICE FOR EACH FEDERAL ORDER

Northeast (Boston)	$16.59
Appalachian (Charlotte)	$18.56
Southeast (Atlanta)	$18.88
Florida (Tampa)	$20.74
Mideast (Cleveland)	$15.80
Upper Midwest (Chicago)	$15.11
Central (Kansas City)	$15.25
California (Los Angeles)	$15.17
Southwest (Dallas)	$16.13
Arizona (Phoenix)	$15.50
Pacific Northwest (Seattle)	$15.18
ALL FMMO MARKET AVERAGE	**$16.63**

Prices reflect Federal Order minimum blend prices for city shown.

2020 MILK VOLUME (Million #)

Northeast (Boston)	11,464
Appalachian (Charlotte)	2,296
Southeast (Atlanta)	2,014
Florida (Tampa)	1,089
Mideast (Cleveland)	8,732
Upper Midwest (Chicago)	12,510
Central (Kansas City)	7,090
California (Los Angeles)	10,132
Southwest (Dallas)	5,344
Arizona (Phoenix)	2,210
Pacific Northwest (Seattle)	3,320
ALL FMMO MARKET TOTAL	**66,203**

Total Grade A milk volume sold under FMMO.

2020 AVERAGE JERSEY REGULATED BLEND PRICE

Northeast (Boston)	$20.43
Appalachian (Charlotte)	$21.20
Southeast (Atlanta)	$21.61
Florida (Tampa)	$23.31
Mideast (Cleveland)	$18.93
Upper Midwest (Chicago)	$18.95
Central (Kansas City)	$18.86
California (Los Angeles)	$16.78
Southwest (Dallas)	$19.21
Arizona (Phoenix)	$17.82
Pacific Northwest (Seattle)	$18.27
ALL FMMO MARKET AVERAGE	**$19.58**

Prices reflect FMMO minimum prices at Jersey component values.

2020 AVERAGE JERSEY BLEND WITH ESTIMATED PROTEIN OR CHEESE YIELD PREMIUMS

Northeast (Boston)	$20.67
Appalachian (Charlotte) (includes protein prem.)	$21.56
Southeast (Atlanta)	$21.61
Florida (Tampa)	$23.31
Mideast (Cleveland) (includes protein premium)	$19.56
Upper Midwest (Chicago) (includes cy premium)	$19.20
Central (Kansas City)	$18.86
California (Los Angeles)	$16.78
Southwest (Dallas)	$19.21
Arizona (Phoenix) (includes protein)	$18.17
Pacific Northwest (Seattle)	$18.27
ALL FMMO MARKET AVERAGE	**$19.75**

Includes a protein premium of $0.05 for every 0.01% increase in protein over the market average.

2020 AVERAGE DOLLAR DIFFERENCE: JERSEY MILK WITH PREMIUMS VS. STATISTICAL BLEND PRICE

Northeast (Boston)	$4.07
Appalachian (Charlotte)	$2.58
Southeast (Atlanta)	$2.39
Florida (Tampa)	$2.65
Mideast (Cleveland)	$3.74
Upper Midwest (Chicago)	$3.92
Central (Kansas City)	$3.52
California (Los Angeles)	$1.71
Southwest (Dallas)	$3.18
Arizona (Phoenix)	$2.68
Pacific Northwest (Seattle)	$3.19
ALL FMMO MARKET AVERAGE	**$3.06**

Prices reflect difference between Jersey price with premiums, and the statistical blend price.

2020 AVERAGE PERCENT DIFFERENCE: JERSEY MILK WITH PREMIUMS VS. STATISTICAL BLEND PRICE

Northeast (Boston)	24.4%
Appalachian (Charlotte)	13.5%
Southeast (Atlanta)	12.3%
Florida (Tampa)	12.7%
Mideast (Cleveland)	23.4%
Upper Midwest (Chicago)	25.5%
Central (Kansas City)	22.9%
California (Los Angeles)	11.3%
Southwest (Dallas)	19.8%
Arizona (Phoenix)	17.2%
Pacific Northwest (Seattle)	21.2%
ALL FMMO MARKET AVERAGE	**18.6%**

Percent difference in Jersey price with premiums, over the statistical blend price.

ESTIMATED JERSEY MILK COMPOSITION 2020

Butterfat	5.09
TRUE Protein	3.80
Other Solids	5.73
Solids Not Fat (SNF)	9.53
Cheese Yield (90% Fat Recovery, 38% Moisture)	13.16
CME Block Cheese Price	$1.66

REGULATED MILK PRICES 2020

FMMO Milkfat	$1.7416
FMMO True Protein	$2.6816
FMMO Other Solids	$0.1730

AVERAGE JERSEY PRICE ADJUSTMENT PER CWT: 2020

FMMO Milkfat Adjustment	$2.04
FMMO True Protein Adjustment	$1.63
FMMO Other Solids Adjustment	($0.01)